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Divisional Forest Officer,
Dharwar-Rajapur.

Government of Bombay

MANUAL

OF

ROAD AND CANAL SIDE ARBORICULTURE

(BOMBAY STATE)

1950

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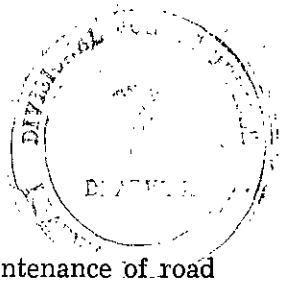

PREFACE

With a view to placing, the planting and maintenance of road side avenues in the country on a satisfactory and systematic footing, the Government of India advanced, certain suggestions for the consideration of the Local Governments in 1905. Eventually, in 1910, the Government of Bombay accepted the view of the Government of India, that the authority responsible for the construction and upkeep of a road, should provide and maintain trees by the side of the road. In 1913, a Manual of Arboriculture was issued, for the guidance of the offices concerned.

2. The manual issued in 1913, had to be supplemented by several orders of Government on the subject issued from time to time. It was felt that the Manual was out of date in many respects and the question of revising the Manual and bringing it uptodate engaged the attention of Government.

3. This book is a revised edition of the old Manual of Arboriculture. The contents of this edition have been brought up-to-date and some of the chapters of the old publication have been suitably summarised and amalgamated. Those portions of the old book which were now irrelevant and outmoded have been omitted in this edition, and now ideas on the subject of roadside arboriculture incorporated at suitable places. In order to enhance the usefulness of the book, English (E.), Hindi (H.), Marathi (M.), Gujarati (G), and Kannad (K.) names have been given, wherever possible, along with the botanical names of the species of trees mentioned in the Manual.

4. This edition supersedes all previous orders in the matter.

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AMENDMENT SLIPS

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MANUAL OF ROAD AND CANAL SIDE ARBORICULTURE 1950

CHAPTER I

PRELIMINARY

The importance of the provision and maintenance of trees along roadsides, because of the welcome shade afforded thereby to wayfarers, the substantial addition to the beauties of the landscape, and the mitigation of the discomforts of long journeys by road, needs hardly to be stressed. In recent years, great havoc has been caused in some tracts by the mutilation and indiscriminate cutting down of trees as a result of famines and due to acute shortage of fuel.

2. Government therefore desire that the old practice of planting and maintaining avenues along public roads and canals shall now be restored and taken up on a systematic basis and have ordered the revision of this Manual with the object of securing steady progress, and ensuring that effort shall be concentrated and properly directed on a pre-arranged plan.

3. This work must, in future, be treated as an integral part of maintenance, and should be considered, in allotting funds, in conjunction with the maintenance of the roadway and canals. The main object is to provide a continuous avenue of healthy shade giving trees, especially in the hot weather, each having ample room to develop its natural shape and beauty of flowers. The authority in charge should keep a separate account of its income from and expenditure on arboriculture; *vide* Appendix A.

4. It is essential that, as far as possible, the sympathies of the neighbouring population should be enlisted in the preservation of the trees. When a fodder famine is prevalent judicious arrangements should be made to utilise the edible leaves of trees as fodder for the cattle. This does not mean that the trees themselves should be heedlessly mutilated or cut down, but that a temporary sacrifice of sylvan amenity may be gladly accepted in the interest of saving valuable animal life. The practice of lopping or otherwise injuring a beautiful avenue for the purpose of the reception of a high Government official, or the passing of a party or procession in carriages is forbidden.

5. Further experience will doubtless render necessary a revision of this Manual. All officers concerned with such work are requested to forward to the Chief Engineer Public Works Department notes of errors found or improvements suggested. Amendment slips will be issued from time to time ; these should be pasted in their proper place, and a note of them made in the form provided for the purpose.

CHAPTER II

Administration and Control

Administrative and financial control

1. The chief administrative control will rest with the Government in Public Works Department. This control will be exercised through the Superintending Engineer, where the work is carried out by the Public Works Department, and in other cases through the Collector. The financial control will be exercised by the Superintending Engineers.

Technical control

2. The chief technical control will be exercised by the Chief Conservator of Forests through whom all technical questions which require the orders of Government should be referred. Working plans must be submitted for approval to the Conservators of Circles who will advise officers on technical matters when required.

Executive control.

3. Executive control will be exercised by (1) the District Local Board or (2) Municipal Boroughs or (3) the Public Works Department. Arboricultural operations on roads and canals maintained by the Public Works Department will be carried out by the Executive Engineer of the Division. Operations on roads maintained by the District Local Board or a Municipal Borough will be carried out by the agency which maintains the road.

4. The working of each of the agencies named will now be discussed separately as far as practically convenient, but, where the remarks or instructions affect more than one agency, they will be found under that agency with which their connection is most important.

District Local Boards

5. It will probably be found that the allotments made for arboriculture by the different Boards are very unequal in proportion to their income. It appears desirable that, without insisting on too rigid a uniformity among bodies which are independent, some reasonable approximation to a general standard of allotment should be attained, but the more arid districts would seem bound to make larger appropriations in proportion to their income than those having a heavier rainfall, as, besides the greater difficulty in securing good results, the shade and vegetation obtained are in themselves more precious; and this appears feasible because such districts have generally to spend less on the repairs of their roads.

Nurseries

6. The foundation of district arboriculture is a sufficient number of well-stocked nurseries. There is a great risk of waste of money in organizing planting operations without a full supply of young plants. Trees are seldom ready to plant out until they are two years old. None should be planted out under 3 feet high. Nurseries should ordinarily be established along roads at suitable distances. Experience shows that nurseries are not usually provided in sufficient abundance, and the District Local Boards should take intelligent and provident action in the matter of providing nurseries. They should be near to the projected work and as numerous as circumstances may require. They will often be made on hired land, when they will be given up after the planting operations are completed. For such nurseries good soil and the existence of a well or other means of watering the plants are the first consideration.

Avenues

7. It will be found that, in most districts, the planting of avenues has been conducted on the sensible plan of working outwards from the head-quarter station. This arrangement probably

affords shade to the maximum number of travellers ; it serves to indicate the order in which the work should be undertaken and it should be followed in every taluka. But the effectual protection of the young trees already put up is of greater importance than new work, which should never be allowed to extend beyond the limit within which efficient protection can be guaranteed.

Staff

8. The staff employed will be of two kinds—Supervising and Executive. The former will be generally from the engineering staff and the latter will consist of those employed in the nurseries and in planting and maintaining the trees at the roadside. It must be realized that the work of growing trees for avenues is distinct from forestry and agriculture, in both of which natural selection by competition is more or less advantageous and economical. The establishment of trees at the roadside is necessarily a costly operation, and each tree in the nursery, which is intended to be planted at the roadside, must be so carefully tended that the period of maintenance, and the number of casualties, at the roadside shall be reduced to the minimum. The work to be done at the nurseries and on the roadside, is not such as can be done by an untrained cooly or cultivator, and it is essential that an ample staff of competent malis shall be employed, especially in the nurseries. There should be at least one capable mali at each head-quarters nursery. If a sufficient number of competent malis cannot be obtained it will be the first duty of this mali to select and train coolies or cultivators. Some of these coolies may be found competent later to take charge of the roadside nurseries, but it cannot be too strongly urged that efficiency and economy in roadside tree planting is chiefly dependent on the competence of the Executive staff. Good malis are not easily obtained and are worth paying well. Certificates are usually of little value and a practical trial is essential. The money needed for obtaining a capable Executive staff and retaining them afterwards should not be grudged.

9. The same trained staff is required for planting the avenues at the roadside and this operation should be considered as part of the work of the nursery. When the trees are planted the work to be done will consist of watering and protecting them. Both must be carefully and systematically done. The bhistis or

other engaged in watering must be trained and their work inspected frequently until they can be trusted. It is important that the same person should be responsible both for watering and protecting the trees. Also the men employed in pruning and lopping must be specially trained. If it cannot be done properly it is better that it should not be done at all.

10. The importance of employing efficient and capable staff for the sake of economy has been strongly urged, and the same principle applies to the provision of the implements required, such as spuds, hoes, knives, secateurs, hose, watering pots, etc. Money spent in providing the stock required of these will not be wasted if the malis are made to use them. Every year the Department of Parks and Gardens conducts a Bagwan (malis) class at the Government Public Park (Poona University) at Ganeshkhind (Poona) which gives comprehensive training to malis especially in ornamental horticulture and arboriculture. Some intelligent members of the executive personnel may be sent there for a three months' short course in Arboriculture.

Working plans and maps

11. Great importance is attached to well-considered plans of operations extending over several years as, without them, there can be no sustained progress. The preparation of working plans will be described and a form given later. If possible this form should be adhered to but, if this is not practicable, any simple plan will suffice which shows clearly the expenditure necessary, for each portion of the work taken in hand, year by year, from the time that the nursery is formed to the time that the avenue needs no further protection. For the preparation of the working plan it is very advisable to have a map showing avenues already in existence indicating the numbered trees, with gaps noted, avenues still under protection and the portions of road proposed to be taken in hand.

Reports and returns

12. Every five years the Local Board shall prepare a concise report showing the progress made and work done on roads which have been permanently constructed and are being maintained. The report should show for each road the condition of the road in respect to roadside trees in the beginning of the period under report, the progress made in filling gaps, in

maintaining recently planted avenues, and in extending avenues to stretches of road not before planted. Statistics should be given of the trees planted out, the survivals and the losses, the income and the expenditure, and the condition of the nurseries keep Government fully informed of the progress made. (if these are used), together with all information required to These statistics may be entered as far as possible in the prescribed forms. They will be submitted to the Collector who will transmit them with remarks to the Superintending Engineer. The Superintending Engineers will consolidate the reports for their Circles and forward them to the Chief Engineer Public Works Department. The Chief Engineer will prepare a consolidated report for the whole Province.

Municipal Boroughs

Scope of operation

13. The above instructions and remarks apply *mutatis mutandis* to all Municipalities though the scope of their work is smaller than that of most District Boards. Ornamental gardens and public parks will be more prominent features in their arboriculture ; but it is important that their attention should be directed to avenues and nurseries, and there is certainly room in most towns for development in this direction. It is true that the minor towns have frequently but a small margin of income available for arboriculture, and in many Municipalities there may be no need for a working plan, but where circumstances render the provision of roadside trees in Municipal limits a suitable and practicable object the Municipal bodies should be moved to prepare plans in accordance with the foregoing instructions so far as they are applicable. Where arboricultural operations are found possible the reports and returns will be submitted as laid dowr for District Boards.

Public Works Department

14. The above instructions apply, *mutatis mutandis,* to the work of the Public Works Department. The staff of the Department will be available for supervision. The reports and returns in appropriate forms, *vide* appendices C andD, will be submitted to the Superintending Engineers who will consolidate them for their circle and forward them to the Chief Engineer Public Works Department.

CHAPTER III

WORKING PLANS

1. A working plan of operations should be drawn up in consultation with the Conservator and when the plan has been finally adopted it must be carried out.

General instructions

2. Plans for five years in advance should be submitted to the Conservator two years before the expiry of the period covered by the existing plan. They should be generally in the form shown in Appendix B with such modifications as local circumstances may render necessary. Each plan must provide for the maintenance of all avenues on which the trees are not yet established, and the balance of the grant available must be allocated to extending avenues or filling gaps in existing avenues so far as funds for the maintenance of the new work can be assured in future years. The term "established" means that the trees have made such progress that they can be left to themselves, and no longer require irrigation or regular protection.

3. In order to draw up a plan it is necessary to know the annual grant, the cost of maintaining a mile of young avenue, the cost of planting a mile and maintaining it for the first year, and the number of years for which young trees of various kinds require irrigation and protection. The first datum is usually known with certainty; the others must be ascertained from past experience in the district, and no general standards can be laid down.

Choice of Roads

4. The next step is to choose the roads on which the new planting should be done. In this connection the following points require consideration.

(*a*) The amount of traffic on the road. As the first object is to provide shade for travellers and improve the general landscape aesthetically it is obvious that those roads should first be planted on which the traffic is greatest.

(*b*) The suitability of the soil for planting.—Unplanted roads running through fertile loam should have the preference, provided they are sufficiently wide to allow space for the

trees without interfering with traffic or putting the trees on the very edge of fields lying along the road. Where there is no room for a line of trees on each side of a road it may be found that one line can be planted ; this should be on the south or west side so as to give shade during the hottest part of the day.

5. The question whether the money available for new planting should be given to work on unplanted roads or to filling up gaps in existing avenues is often difficult to decide. It is desirable in many ways that an avenue should be continuous, but there is frequently some difficulty in getting single trees to grow in a line with larger trees as the roots of the latter deprive the former of moisture ; or again it may be found that the existence of a gap is due to barrenness of the soil. Further, it usually costs much more to plant and maintain 100 trees spread over several miles of road than the same number at one place ; the mali has to go further, water is more difficult to get, and neglect is much more probable. When again an avenue is drying, it is a waste of money and effort to fill the gaps as they occur : it is better to wait a few years until the whole or almost the whole can be replanted. On the whole it may be said that where there are roads with heavy traffic and suitable soil still unplanted, it is better to concentrate effort on them than to expend it in filling small gaps in established avenues ; while where no suitable roads are left without avenues the money available should be devoted to filling gaps.

Choice of trees

6. Having selected the roads to be planted, the next step is to decide what trees are to be planted on them. The considerations which affect this decision are dealt with in Chapter XIV.

Location of nurseries

7. The next step is to decide where nurseries shall be located. It is always desirable that a nursery should be as near as possible to the length of road to be planted, as this reduces the expense of carriage and makes it easier to transport the young trees without injury. On the other hand, it is essential that the nursery should be so situated that it can be frequently inspected, that the soil is good, and that shade and water are

available. The question must, therefore, be decided on a consideration of the circumstances of each case.*

*Note.—In some places it has been found possible to establish nurseries in the compounds of inspection and such other bungalows and to place the caretaker in charge. This has worked very well where the caretaker happened to be careful gardner. As water is always to be had the caretaker has plenty of leisure and the nursery can be inspected by officers using the bungalow. But everything depends on the skill of the caretaker.

Alterations in plans

8. It may occasionally be necessary to depart from the sanctioned plan. If the plan has been carefully framed, it will hardly ever be desirable to plant more than has been provided for : and to do so frequently leads to difficulty in maintaining the extra work, which has not been provided for in the plan for future years. But a very unfavourable season may prevent planting from being carried out. Should this happen, or should there be an accidental omission, the plan should be revised so as to provide for a little more planting in the next year, care being taken that money is available for its maintenance. All revisions of plans should be submitted to the Conservator for approval. Similarly, if the District Board finds that it is in a position to increase the annual grant available for arboriculture, a revised plan should be submitted for approval.

Map of avenues

9. To facilitate the preparation of plans and the supervision of operations, on outline map of the district should be maintained showing all the roads and the established avenues. New lengths of avenue should not be shown as such on the map till they are established (paragraph 2). A simple plan is to show the avenues when planted in dotted lines on each side of the road, with the date of planting, and to convert the dotted line into a full line as each length of avenue becomes established.

CHAPTER IV

Tools required for arboricultural works

1. Various English implements are generally recommended in English books on gardening in India. But in tree-growing

most of the work is often done by ordinary untrained coolies, who will use nothing but the tools they are accustomed to handle. And very often it will be found that these tools are more suitable for the work to be done by the class of men available than English implements.

2. Of Indian tools which are admirably adapted to the purposes for which they are used may be mentioned, besides the usual and well-known agricultural instruments, the "'vahaula" or "hoe axe", used for stubbling out roots, etc.; the "kurpa", or "ramba" of universal use by coolies in nearly all gardening operations; and the grass-cutters "daranti".

3. Hedge-pruning instruments of English make are, however, necessary. These are a hedger's bill or bill-hook, shears, and pruning knives.

4. In pruning and thinning the following instruments are required:—

Sharp knives

Indian saws (thick for greenwood), with long and short handles.

Pruning chisels, with long and short handles.

Wooden mallets.

Pruning knives are made with or without a hinge.

5. Pruning saws ought to have very fine teeth, and some ought to be provided with handles of various lengths, to reach branches at different heights. The Indian saw differs from the common saw in having the teeth pointed inwards, and is thus used by being drawn towards the operator. This saw is well fitted for removing branches at a distance from the pruner. For large branches saws about 18 inches long are well adapted.

6. The long-handled pruning chisels are used when the pruner cannot otherwise reach the branches, or finds it difficult to remove them with the saw. Some implements are shown in plate No. I.

CHAPTER V

Collection and Preparation of Seed

1. Trees for planting avenues may be obtained from seed, cuttings, or root suckers. Other forms of propagation, such as

layering, grafting, budding and inarching belong to gardening and would rarely be employed and then only in the vicinity of large towns where skilled advice can be obtained.

Collecting seeds

2. It is generally preferable to select for avenues trees which grow naturally in the locality or have become already acclimatised in it, if suitable for the purpose, as it is easy to judge of their adaptability to the soil and climate; and in such case it is better to collect the seed locally as it can then be had fresh and good. But if it is desired to try trees, the seed of which cannot be collected in or near the district, good seed can be obtained at small cost from any of the public gardens, such as the Department of Parks and Gardens, Fort Bombay, the Empress Gardens, Poona, the Victoria Gardens, Bombay, etc.

3. Seeds should not be collected until they are ripe. There are generally signs, characteristic for each kind of tree, by which the ripeness of the seed may be recognised; as a rule sound seeds are moist, of full weight, and of a healthy colour and appearance when fit to gather. The seasons in which the seeds of each kind of tree recommended for cultivation ripen are given as far as possible in the list of trees suitable for road-side planting; but this should be taken only as a general guide as the time of ripening varies in different localities. Many trees shed their seed as soon as it is ripe and, as it is often easier to gather the seed while still on the tree, the progress of the ripening of such trees should be carefully watched so that the seed may be gathered before it is shed. In other cases, such as sissu, babul, etc., the seed remains on the trees for a long time and keeps well, and the same care is not required. The best seed is furnished by healthy mature trees alone and care should be taken that the seed is collected from full grown, well formed and sound trees. The seed should be collected on dry days and, when gathered, should be spread out to dry in the shade.

Clearing seed and preparing it for sowing

4. In many cases it is necessary to remove the fruit or other covering of seeds by artificial means before sowing them or preserving them for sowing at a later date. Where the seeds are contained in pods the pods open naturally when dry and either shed their seed or at most a little threshing or other

manipulation will be required. Where the seeds are enclosed in a fleshy covering as in the case of the ber and edible stone-fruits, this covering can be rotted off by burying the fruits in layers in moist earth or sand. Some seeds such as those of the teak have hard coverings, which can only be removed by prolonged treatment in this manner. If the quantity to be dealt with is not large and the saving of time an object, seed of the above description may be prepared for sowing by being soaked in water and frequently stirred for a considerable time, or by being buried in moist manure, where they will get both warmth and moisture, and kept there until they are about to germinate. Seeds of the Ficus species germinate best if sown on the top of a layer of half decomposed cowdung in a shady place.

5. Some seeds germinate better after keeping or after passing through the bodies of birds or fruit eating animals. Babul seed, for instance, gathered from goat yards germinates more freely than fresh seed.

Preservation of seed

6. The seeds of some kind of trees, such as the mango, neem, jambul, guava and bael and generally most oily or resinous seeds do not retain their germinating power for long and should be sown as soon as possible after being gathered. It is nearly always safest to sow at once all seeds that ripen at seasons suitable for sowing. But some seeds ripen at times not suitable for sowing and the germinating power of some seeds, such as those of the babul and other acacias and some of the cassias, is improved by keeping. Such seeds may be stored in a dry, well ventilated place, where they will not suffer from damp; or in pits excavated in dry raised ground where excess of air and moisture is excluded, and where they can be preserved from the attacks of insects and vermin. One of the best ways is to spread them loosely in layers a few inches thick on a pakka floor as this allows them to be turned over at intervals which should be done especially when the seeds are freshly gathered. As a protection against insects where these are more than usually prevalent it is often useful to mix with the seeds bitter leaves, such as those of the neem or bakain or powerful smelling drugs. Mixing of Gamxona powder a newly introduced insecticide in small quantity with seeds completely prevents all kinds of insect attacks in seed storage of small or large magnitude. Rats, mice, and smaller vermin may be kept off by storing the seeds in Gharras or tin-lined boxes, if in

small quantities, or in the drawers in an almirah. Seeds can also be well kept and protected from damp by suspending in sacks from the roof of the godown, or in large baskets supported on trestles, and by similar devices.

7. Seed which has been allowed to become damp may suffer from mildew or fermentation. To prevent this it should be carefully dried in the shed before it is stored. This is especially important where the seed is to be stored in closed receptacles, such as bottles, tins, etc. Seed which is naturally full of moisture or fleshy may be stored for some time, mixed with dry earth or charcoal dust, in a box or gharra but it is preferable to sow such seed at once whenever possible.

Testing seed

8. As it is a waste of ground, labour and money to sow bad seed, all seed should be tested before sowing whenever there is any doubt of its soundness. A rough practical test may be made by placing some of the seed on an iron plate nearly red hot, when all the sound seeds will burst before burning and the proportion of sound seed can then be judged. A more reliable test, which however takes a longer time, is to sow some of the seed, after counting, in a pot of moist earth, and keep it in a warm and preferably dark place. The number of seeds which germinate can then be counted and this will show the proportion of good seeds.

Quantity of seed required

9. It is impossible to give any general rules for estimating the quantity of seed required to produce a given number of plants, but it may be said that, as a rule two plants should be raised for each one that is required for planting. Some seeds germinate freely, some the reverse ; casualties will occur both before and at the time of planting where required ; though the seed is gathered from healthy matured trees alone, the seedlings will very in health and vitality and all weakly seedlings should be scrapped. As a rule, therefore, a very much larger quantity of seeds should be sown than would apparently be sufficient to give the number of plants required.

10. In arranging for the collection or supply of seeds an ample margin should be provided to allow for failures in germination and for weakly seedlings which have to be rejected ; to

assist in finding the quantity of seeds required, the number of seeds to the seer is given, where known, for each kind of tree in the list of suitable trees.

CHAPTER VI

PROPAGATION OF TREES; NURSERIES

Methods of propagation

1. There are various methods of propagating trees :—

(1) Direct sowing of seed where the tree is required to be grown;

(2) Sowing the seed in seed-beds and transplanting direct to site.

(3) Sowing the seed in a seed-bed transplanting the young seedlings into pots or into the ground in the nursery, and then planting them out in their permanent positions when they are large enough;

(4) Planting cuttings ;

(5) Detaching and planting root-suckers.

Of these methods, Nos. (3) is the most importnat for those for whose guidance this manual is intended. For roadside tree-planting, the method of transplanting the seedlings into pots or baskets is the best. Cuttings may be used in the case of species which do not seed freely ; or, in order to obtain plants of some size, as in the case of the different species of Ficus which root fairly readily. An avenue (of Babul, for instance) can be reared, by sowing seed in situ, in prepared pits, along the sides of the road and afterwards thinning out the seedlings.

Selection of sites for nurseries

2. In selecting the nursery, the following are the chief considerations to be taken into account, viz., (1) locality, (2) facilities for obtaining water, (3) shade requirements, (4) soil, (5) facility for supervision. The site of the nursery should be above the level of floods and as near as possible to the road or portion of a road which is to be planted. It should be made large enough to meet the requirements for which it is made. It will often be found convenient as already stated to establish a nursery in the compound of an Inspection Bungalow, where

the bungalow chaukidar or Mali can tend it and inspecting officers can from time to time watch progress and see that their Instructions are being properly carried out. A never-failing supply of water from a well or from a tank or canal is indispensable. A site with a few shady trees on it should be selected for a well-drained loam. Proper drainage should also be provided to allow water to run off. The nursery should be fenced. Plants can be sent considerable distances quite safely, provided they are properly prepared, packed, protected from the sun, given sufficient water and carefully transported to their destination. Local officers can, therefore, decide to locate their nurseries at such places as they consider will, from time to time, be most suitable for meeting the requirements of their respective districts.

Laying out nurseries

4. The ground should be dug and thoroughly worked to the depth of from 15 to 18 inches. If the soil is not quite suitable, it can be improved by the addition of such materials as appear to be required. Every nursery should have a pit wherein leaves can be stored and allowed to decay, in order to provide a supply of leaf-mould for manurial purposes. The nursery should be laid out in beds five feet wide, running, approximately, in the direction of the natural surface drainage, and the beds should be separated one from another by paths 2½ feet in width. In the monsoon the seeds should be sown on raised seed beds at least six inches from the ground. This prevents water-logging conditions in the seed-bed.

Preparation of beds and sowing of seeds

5. Before sowing, the soil in the beds should be broken very finely and have some finely-sifted leaf-mould or manure mixed with it. It should then be raked smooth ; then moistened, but not made so wet as to cause it to stick to the fingers at the time when the seed is being sown. The seed should be sown evenly, broadcast, and then covered with a thin layer of fine soil not deeper, as a rule, than twice the thickness of the seed itself ; or the surface of the bed may, simply, be raked.

Time for sowing ; watering ; protection and shade

6. It may be stated, as a general rule, that the proper time for sowing seed is the season when it is ripe and falls from the

tree. Seeds can, however, be sown at almost any time of the year, provided they receive proper attention in regard to shade and watering. Every nursery should be provided with, at least, one watering pot fitted with a fine-holed rose for watering seed-beds. From the time the seeds are sown till after the seedlings are above ground they will require constant and very careful attention in regard to watering and protection from animals birds and insects. For insects, ashes or lime may be sprinkled over the beds; while kerosene emulsion, tobacco water, or a weak solution of copper sulphate may be applied to plants by syringing (*vide* Appendix E). The beds should be shaded from the midday sun and from heavy rain by having bamboo mats placed over them. Caster-oil plants may usefully be grown to provide shade quickly.

Weeding, cultivation and thinning

7. The beds must be carefully weeded, and the surface broken up with a pointed iron pin after each irrigation, to prevent a "cake" forming. This loosening of the soil is necessary to enable the seedlings easily to force a way through it, and also to enable the young plants to grow properly. The seedlings must be carefully thinned by removing the weakly and ill-formed and leaving only the healthy and well-formed plants.

Transplanting

8. The next step will be to transplant the seedlings into pots or baskets. This may be done as soon as they are from 6 to 10 inches in height and the greatest care must be taken to lift the seedlings without harming the roots. If any root be broken, the broken portion should be cut off with a sharp knife. Dead or dying twigs or leaves should be removed by cutting or by hand picking. The seedlings should be lifted with the soil adhering to their roots, and this soil should not be removed till the seedling is being transplanted into the pot or basket. The pots or basket should all be ready beforehand, and the soil that is to be put into them should also be ready mixed with manure, so that there may be no delay between lifting the seedlings and replanting them. After the seedlings have been potted or basketed the pots or baskets should be neatly arranged in rows and kept in a shady place till the plants become established.

Season for transplanting

9. The season for transplanting depends much on the species of tree and on the climate. As a general rule it is

safest to wait till the rains break. Transplanting in winter is, however, often successful in the case of trees which are leafless in the cold weather.

Use of pots or baskets; lifting

10. It must rest with the local officers to decide whether pots or baskets should be used. In some localities earthen pots may be too expensive to warrant their use, but other conditions being the same, pots are perhaps more satisfactory. They should be from 7 to 9 inches in diameter. It is best to arrange the pots in shallow trenches so as to facilitate irrigation; and the pots should be moved occasionally to prevent the roots striking into the ground beneath. It is a common practice to bury the pots in the ground, but by doing this there is more danger of the roots penetrating into the earth beneath and being damaged when the pot is lifted. At least 50 per cent more plants than are actually required for planting should be potted. It is by no means indispensable to transplant into pots or baskets. The seedlings can be left to grow to a larger size if they are transplanted into the ground, in lines, 2½ feet apart, but the difficulty of "lifting" them is then much more serious; and unless a trained subordinate personally supervises the process, the Mali is sure to damage the roots, which spread very much further than when confined in a pot and become interlaced with the roots of the adjoining plants.

Propagation by cutting

11. As a rule straighter trees can be grown from seeds than from cuttings. In the case, however, of certain trees—like Sisso, and Mulberry—of which it is desired to raise a stock of plants quickly, cuttings may be made from 8 to 10 inches in length, and planted obliquely, fairly close together, in prepared beds in a shaded position in the nursery. As soon as the cuttings have become sufficiently well rooted, they should be potted and grown on in the nursery till such time as they are ready for permanent planting.

Also, large, straight, selected branches, 1 to 1½ inch in diameter from 3 to 5 feet in length, can be cut off the parent trees of the Banyan, the Pipal, and other members of the fig family, and also Pangara, Bombox malbaricum thespesia and planted as cuttings in a shaded position in a nursery. As soon as those which succeed have made a satisfactory amount of root growth,

they may be transplanted to the positions which they are intended to occupy permanently as roadside trees. As, however, the percentage of these large cuttings which will strike is always uncertain, the method is not recommended for general use. But in certain localities where rainfall is adequate the tree cutting mentioned above may be planted in "situ" after few heavy showers at the beginning of the monsoon. If the rains fail it will be necessary to water these cuttings by water cart.

CHAPTER VII

FORMATION OF AVENUES

Only large healthy seedlings to be planted

1. Only the healthiest and best shaped plants in the nursery should be planted along the roadsides. Sturdy young trees are wanted, and the planting out of forced or weakly seedlings must be rigidly prohibited. The young trees to be planted should be from 2 to 4 feet high. In proportion to their age, they should have good, straight, stout, well-developed, clean stems; and every care should be taken, when moving them, to cause as little injury to their roots as possible. The seedlings will usually be ready for planting out when they are from one to two years old. Wherever it is practicable, the plants should be conveyed in their pots or baskets to the roadside where they are to be planted—care being taken to protect them in every way in order to prevent them from flagging at any time. It is best to carry out the planting work during a spell of cloudy or damp weather.

Position of trees in relation to the roadway

2. Trees should never be planted on the very edge of the roadway, as the roots are liable in such cases to burst through the surface, damaging the road and tripping up bullocks and horses. In addition, the shade becomes too dense, and the trunks are dangerously close for passing carts. On the other hand, trees should never be planted on the extreme edge of the land belonging to a road running between cultivated fields as the shade will then injure the crops.

How to align an avenue

3. In planting avenues, it is desirable to begin by laying out the centre line of the road with ½ inch thick rope, correcting any askward curves or bends in order that an improved and fairly easy curvature may be obtained for the avenue. The two side lines should then be measured off from the centre line, and the pits, in which the young trees are to be planted, marked zigzag at the distance apart that has been decided upon. For setting out straight roads, flagged-poles will be found useful.

Range of width of avenues

4. The width of the avenue to be planted will be determined by the class of the road and the height of the embankment above the average ground level. Generally speaking the following widths will be found suitable, *vide* plate II.

(1)	National Highways ...	80 feet
(2)	Provincial Highways ...	80 feet
(3)	Major District Roads ...	50 feet
(4)	Other District Roads ...	30 feet
(5)	Village Roads ...	30 feet

Range of distance apart suggested for different species

5. The distance to be left between each tree in a line will depend chiefly on the species, and partly on the soil and climate. The important point to remember in this connection is not to plant trees too closely. Generally the spacing between the trees should be between 30 and 50 feet.

Remarks regarding the planting of different species in an avenue

6. It is advisable to plant trees of the same species in the same length or section of a new avenue. There is, however, no objection to filling up vacancies in an old avenue of mixed species with young trees of different suitable species.

Preparing pits

7. The pits must be at least of the size required to take in the ball of earth, or the roots, with sufficient space to firm the earth filling between the ball or roots and the sides. And, as

will be explained later, it is advisable to place a good sized gharrah in each pit for economy and efficiency in watering. But, unless the soil is naturally very rich, it is advisable, as will be explained when dealing with the soil for filling the pits, to have a good body of rich soil in the pit to push on the growth of the tree and reduce the period for which maintenance is required. For this reason the pits should be at least 4 feet wide at top and 3 feet wide at bottom and 3 feet deep. In street planting the size may with advantage be increased but a depth of four feet is sufficient. The shape of the pit is immaterial.

8. The pits should be dug as long as possible before the planting is expected to commence, so that the soil taken from them may weather before it is required for filling in again. The upper soil to a depth of about 1 foot from the surface is the best and should alone be used for mixing with the manure for filling near the plant. When digging the pits it should, therefore, be kept on one side for that purpose. In March or April each pit should be half filled with dry leaves which will become saturated on the first fall of rain. In planting the leaves should be drawn away from the middle and the bottom of the hole so as to leave a clear space 3 feet deep by 2 feet in diameter, which should be filled in with prepared soil on the centre of which the tree should be planted. If there is any reason to think that a bed of sheet kankar underlies the pit it should be dug out and removed.

Soil for filling the pits

9. The best soil available should be used. To encourage growth use manure. A cart-load of good manure mixed with the soil in a tree pit, at the commencement of the monsoon, shortly after the cutting or plant has been planted will result in a saving of one year's cost of maintenance. The manured soil will produce a larger tree in one to two years than unmanured soil will produce in three years. The saving of one year's maintenance charges is well worth obtaining at the cost of a cart-load of good manure, especially where the trees have to be protected from cattle or goats, as the cost of maintaining such protection is great. Where manure cannot be obtained at reasonable rates, a cart-load of black soil should be mixed with the soil in the pits in murrum or red soil and one of red in black soil pits.

Providing arrangements for watering

10. Watering charges are the main source of expenditure in tree-planting and can be reduced by providing each tree pit with a sound earthen pot planted as deep as possible in the pit. A country roof tile (not divided in two for roofing purposes) should be inserted into the mouth of the pot to serve as a channel for the water and to prevent earth falling into the pot. The ordinary gurrah holding about two gallons of water, will, when in contact with earth, exude sufficient moisture into the soil in the pit, to keep a sprouted cutting or young plant alive through the dry season. The rate at which water will pass through gurrahs into the earth depends on the nature of the gurrahs and of the climate, also on whether or not the gurrahs are clean and free from earth inside. If the gurrahs are free from cracks or holes through which water can pass, the water will last from 10 to 20 or more days. Since water carts hold from 100 to 200 gallons, a water cart, making two trips per day, will fill from 100 to 200 gurrahs per day, or, allowing 25 per cent loss in cartage, filling gurrahs, etc., will fill 75 to 150 gurrahs per day. The gurrahs must be filled every ten days and one water cart will then serve 750 to 1,500 gurrahs according to the size of the cart; where the source of supply is not far distant the smaller cart will fill the larger number.

11. The best results will be obtained from using gharas rather deeper and narrower than those in ordinary use; a depth of about fifteen inches with a width of eight or nine inches at the widest part has been found suitable. The side of the ghara which will be turned away from the tree may be painted with coal tar before being buried in the ground; this prevents water escaping at a distance from the roots and thus economises the supply. Special shaped gharas and the use of tar are not essential to the system, which should be adopted in all ordinary cases. With this system there is no danger of over-watering and no waste of water and a glance at the ghara will show at once whether the Mali has been neglecting his work. It is advisable to give each Mali a bamboo pipe about 4 feet long or some similar arrangement by which he can direct the water with certainty into the ghara while standing outside the guard. Most kinds of guards suffer a good deal of injury from the constant entrance of the Mali who cannot often be trusted to make this injury good. Gharas which have been in use a year should be examined at the beginning of the hot weather and replaced

if they are broken or if their pores have become choked by mud. (Fig. 7 of plate III.)

The objection to the plan of using gharas is that unless the ghara is moved at intervals, the tree roots are likely to grow lopsided. Another arrangement is sketched in Fig. 8 Plate III. Good earth to which old manure, if possible, has been added, or road silt, dead leaves, etc. is filled in at the bottom of the hole. On this is built up dry stone of the roughest and cheapest description (quarry rubbish, etc.) leaving a cylindrical space in which the seedling is planted, and is surrounded by good soil, and the top is finished off with clean porous material. When the seedling is watered, practically all the water descends evenly all round to the bottom of the dry stone, very little is evaporated from the space and the rootlets are thus induced to grow downwards and thereby protected from drying by the sun. The holes cost a little, but much less than the value of the watering they save and they give the seedling a good start.

Planting the trees

12. The pits should first be well soaked with water and then filled in with the prepared soil to such a depth that, when the soil has settled, the trees will stand at the right level. The trees should be set so that the earth will stand round the stems at about the same height as in the nursery, being not lower on the stems and not much higher.

Level of planting

13. Special attention is necessary to the level of the soil in which the tree is planted. If it is much above the surrounding soil, the danger of injury from drought is increased; while if it is below the surrounding soil, water collects in excess round the young trees and either kills them or injures them more or less permanently. It is essential, therefore, that drainage should be provided where there is any risk of water collecting. The following rules cover all ordinary cases:—

(*a*) Where the land is high and well drained the trees should be planted flush with the surrounding land.

(*b*) Where trees are planted on the side of an embankment, no special precautions are necessary as water can escape down the slopping bank.

(*c*) Where the land is low-lying, the trees should be planted on mounds about one foot high, with a diameter at least three times the height, and sides sloping very gently. If the sides are steep or the mound narrow, heavy rain may wash the earth away and expose the roots of the tree which will then almost certainly die.

(*d*) The tendency to plant trees below the surface of the surrounding soil must be rigorously checked : malis often prefer this system because it saves trouble in watering and careful supervision of this point is, therefore, essential.

14. Only one tree should be planted in each pit : the common practice of planting several trees and subsequently throwing away all but one is not only wasteful but injurious. If the tree, to be planted, has a ball of soil round the roots, this ball may be placed on the filled soil and then more soil filled in and firmly trodden down round it. It is essential that the soil should not separate from the ball as the ball will then dry and the tree die. This should be watched shortly after planting.

15. There should always be two or three planters, one to hold the tree in its proper position with its collar at about the point where the final ground level is to be, the others to shovel in the earth round the tree and tread it firmly in, taking care that it is broken up fine and not in large lumps. The earth should be slightly raised round the stem and lower towards the edge of the hole, so that, when irrigated, the stem may stand in a little island.

16. If any damage has been done to the roots so that their growth has been in any degree checked, it is advisable to cut back or shorten some of the branches and to remove some of the leaves if excessive. This is of greater importance in proportion to the dryness of the air at the time of planting.

Protecting the young trees

17. It is always necessary to keep the young tree steady until the roots have caught hold of the soil, as otherwise the formation and growth of the roots will be prejudicially affected. If stakes are provided for this purpose two should be used for each tree and these should be placed in the line of the prevailing wind. The band or rope should not be tied round the tree but

should touch it for half its circumference only. The bark should be protected from damage by the rope by interposing a piece of cloth. And the stakes and ties should be removed as soon as the tree is steady without their assistance.

18. The young trees must also be protected from damage by goats and cattle, especially the former. If the young trees are kept as advised, in nurseries until they are of such size that goats cannot reach the leaves, thorny branches tied round the stems may be sufficient. This is a considerable advantage as all forms of protection are costly and the loss of efficiency through attempts at economy is probably more costly than any form of protection. The different forms of protection are dealt with fully under fencing in a subsequent chapter to which reference should be made. It is only necessary to point out here that the protection must be maintained in efficient condition until the tree is established.

Watering

19. It cannot be too frequently pointed out that the watering it the most expensive part of raising avenues and every endeavour must be made to reduce its cost by shortening the period for which watering is necessary. When the tree is first planted the soil should be well and thoroughly watered so that it may be moist to the bottom. Thereafter the principle to be kept in view should be to attract the roots towards the bottom of the pits where the natural moisture is greater. This may be done by placing the water in sunken gharas as explained under "Preparing the Pits". If the trees are watered by irrigation from wells or canals which may in some cases be the most economical method, the water should be kept away from the tree and allowed to reach the bottom of the pit by the use of small pits filled with sand to which the water may be admitted from the water-course when required. Watering by head-loads or bhistis' mussocks or hand-carts is always very expensive and usually inefficient. The common practice by which the bhisti dashes water from the mussock or a pail on to the base or collar of the stem should be abandoned, if in use and never adopted. It damages the stem, prevents growth, and keeps the young feeding roots to the surface at the place where least required.

CHAPTER VIII

(1) MAINTENANCE—PROTECTION

General

1. As soon as the young tree is planted, it requires to be protected against various dangers. A tree may be destroyed by ordinary traffic or by animal grazing or passing along the road; and the method of protection must be such that passengers will avoid the tree, and that animals, especially goats will be unable to reach it, while at the same time traffic must not be obstructed. A large proportion of the failures in road-side planting are due to the inadequate fences made for the protection of the trees planted. It is a common sight to see long avenues of trees planted and watered at very great expense, but protected only by thorn branches stuck into the ground. Trees fenced in this manner are always eaten down. The money spent on them might as well be thrown away. With all forms of guards it is essential that the Mali should be able to reach the soil round the trees and to break up the surface with his kurpi.

Different forms of guards

2. No method of protection can be recommended for universal adoption; the different methods in use are discussed below and the decision which of them shall be adopted must depend on the circumstances of the locality:—

(*a*) *Iron guards* (*Fig. 1 and 7, Plate III*).—These may be made of standards of iron hooped together and enclosed with wire netting. They must be strong enough, that is, the standards must be sunk sufficiently deep, to withstand an animal knocking against them; and they must be high enough to prevent animals reaching over the top. If these conditions are fulfilled, they give perfect protection, but at an expense that appears to be prohibitive in most places. The attempts to produce cheap iron guards have usually been failures; either they have been so weak that they have been destroyed by animals or even passers-by, or they have been so narrow or so short that goats could get at the trees through or over them.

They are suitable in and near towns, where traffic is very heavy, and unsightly forms of guards are open to objection. In such places the best pattern is that made of iron hoop lattice, in two pieces, each framed on iron bars, curved and tapered towards the top. When set up, the two pieces are fastened together with wire. This pattern of guard stands firmly, and has the merit that it can be easily taken off a tree that has out-grown the need of it and carried off to another place; whereas tree guards forming a complete circle are very difficult to remove from trees, and are so bulky as to be inconvenient in transport.

(b) *Wooden guards (Fig. 2 Plate III)*.—Having usually been failures, except to a limited extent in and near towns. The remarks made as to iron guards apply here also, while in addition they are often destroyed by white ants, or the materials are used by the people for fuel.

(c) *Open work brick guards.*—May be used where bricks are available, but they are not very satisfactory. They keep too much light off the plant, if small plants are used, and they gradually disappear as people carry away single bricks for seats or for use in other ways. If they are made tall enough the loss of light is very serious, while if they are low, goats can reach over the top, and thorns must be fastened round them to prevent this. If such guards are used, the top course of bricks should be set in good mortar.

(d) Live hedges.—Probably the cheapest protection is a hedge of cactus, not prickly pear, but babul, agave and other thorny plants may also be used. They should be planted at least a year before the tree is to be planted so as to give the protection at the time when it is required. They may be made effective, but it is difficult to make them grow evenly, and a very small space is sufficient to admit a goat inside the hedge. They should not be allowed too near the tree; four feet is the minimum distance that should be allowed, as otherwise they will compete with the young tree for the moisture in the soil. They must be regularly pruned twice a year in order to prevent their becoming too thick and so stopping light and air from reaching

the tree. Where live hedges are adopted the supervision over them must be constant and vigilant.

(*e*) *Thorns.*—A circle of thorny branches fixed firmly in the ground round each tree may be very effective, if care is taken, and economical if thorns are readily to be had in the neighbourhood. They must be firmly fixed in the ground and pegged down if necessary, and the hedge must be made thick and strong. The thorns will have to be renewed and the hedge repaired at least once a year, and careful supervision is required to insure that the hedge is always effective and especially to see that the Mali fills up any gaps that he may have made in order to get at the ground round the young trees. To prevent this a light bamboo step ladder should be used (Fig. 3 Plate III). These hedges have the disadvantage that they are liable to be broken down and stolen for firewood. Dry thorn loppings piled up round the trees planted make a temporary protection, which is, however, apt to get out of repair and always liable to be broken down, or stolen by passers-by to light their fires. The thorn loppings require to be constantly renewed. By the addition of a mud wall and ditch, the wall being roughly built from the soil thrown out of the ditch, the thorn loppings may be made a real defence. The inside diameter of the circle enclosed by the wall should be at least six feet, the ditch being of course outside the wall ; the ditch to be useful should be two feet deep. But such a protection takes up too much room for use anywhere except on country road.

(*f*) *Mud walls.*—(Fig. 4 Plate III)—This is the commonest form of protection and is effective if the wall is kept in proper repair and enough thorns stuck into the top to prevent animals from reaching over it. The cost of this protection is rather high, and where it is adopted supervision is required to see that the walls are not allowed to fall into disrepair, and that surplus water does not collect inside the guard in wet weather.

(*g*) *Trenches.*—The ordinary trench, dug with steep sides close to the young tree, is most unsuitable. The tree is left standing on a narrow cylinder of earth which soon washes down into the trench and exposes the roots. Where space is available a trench and bank combined

make perhaps the most effective guard of all, provided it is properly laid out. The minimum dimensions of such a guard are given below, and where space for these dimensions is not available, some other form of guard should be substituted.

As has been stated the hole in which the young tree is planted should be at least 3 feet deep and 4 feet in diameter at the top and 3 feet at the bottom. Taking the middle of this hole as centre, draw two circles round it, one of 4 feet radius and the other of 6 feet outside the hole; there will thus be two circles, one of 8 feet and the other of 12 feet diameter. Dig out the earth from the space between the circumference of the outer and inner circles, and throw it up on the space between the circumference of the inner circles and the edge of the plant hole, so as to make a trench (Fig. 5 Plate III), 2½ feet deep, 2 feet broad at the top and 1 foot broad at the bottom, with a sloping mud bank inside it 2 feet broad and 2½ feet high Inside the mud wall will be the plant hole. The ditch will thus be at least 3 feet distant from the roots of the young tree. Some babul thorns should be stuck into the top of the bank while the earth is wet.

The bank and ditch should be made during the rains after the tree has been planted. Little repair will be required and as soon as the tree is old enough to dispense with it, the bank can easily be thrown back again into the ditch, and the ground neatly levelled. Before filling in the ditch it will be as well to take the opportunity of "mulching" the tree roots by half filling the ditch with dead leaves, and saturating them with water. This will tend to draw out the roots and give the tree increased power of resisting drought.

(*h*) Wire fencing is durable and not very costly. The wires must be close together for some height from the ground. The standards usually supplied are too light and are damaged by cattle.

(*i*) Wattle fencing (Fig. 6 Plate III), used where branches of trees, bamboos, or other suitable material is available, is made by interlacing long flexible branches, basket fashion, round stout uprights embedded in the ground. Such a fence costs little when the material for making it is available on the spot. It has, however, all the disadvantages of other wooden fences; it gets out of

repair very quickly and has to be renewed, the material is liable to be stolen for firewood and the fence broken down in consequence. Such guards are, however, used largely and successfully in Bengal.

(*j*) Basket guards of somewhat the same shape have been tried in Bombay and may be economical where labour and materials are available. They have the same disadvantages of other wooden guards and in addition are generally too weak and too small in diameter to form an efficient protection.

CHAPTER IX

(2) MAINTENANCE—WATERING

Need of irrigation

1. In ordinary cases trees require irrigation for the first three years after planting out, but no absolute rule can be laid down, as much depends on the soil and climate and also on the kind of tree. The need of each locality must be determined by experience. The amount of water required varies with the season ; in the rains watering is necessary only during periods of fine weather, but then it is required at very short intervals ; in the cold weather the water lasts much longer, while from March to June constant attention is needed to save the trees from injury.

Water-supply

2. At the time of deciding on the sections of road to be planted, the question of water-supply should be considered, if there is a canal channel cutting the road and giving a constant supply of water, arrangements can usually be made for drawing most of the supply from it. If there is no canal, or only one with an intermittent supply, existing wells can be used, and if there are none, wells must be sunk at convenient distances. Where water has to be carried from a long distance, the expense of irrigation is greatly increased, and there is also greater probability of neglect on the part of the malis.

Conveyance to trees

3. Local conditions determine the cheapest method of bringing water from the source to the trees. Where the distance is not great, water can be carried in gharas, or preferably in kerosene tins, fitted so as to be slung from the shoulders. In this case it is usually necesary to give each Mali a labourer as an assistant during the times when frequent irrigation is needed. It may be more economical to employ Bhistis with Mashaks, those in ordinary use holding about 8 gallons, or bullocks with pakhals holding about 30 gallons. Where the distance is great, economy can be secured by carting the water along the road; It can be carried in barrels mounted on small country carts or in such other way as may be suitable to the locality. It is advisable to give each Mali a bamboo or other pipe about 4 feet long so that he can direct the water to the required place while standing outside the tree-guard; most kinds of guards suffer a good deal of injury from the constant entrances of the Mali.

Application of water

4. The most effective way of applying water to a tree is by means of a ghara buried in the pit. (Fig. 7 Plate III) The ghara can be filled with certainty by means of a pipe as described in the last paragraph. Where this method is not employed and water is applied to the surface of the soil it must be remembered that no trees, except a few which are always found growing by water, will stand the constant application of water to their bark. Road-side trees are frequently killed by kindness of this sort. The bark is split by the sudden change of temperature and the sap-wood rots. It is the roots which need water, not the stem. It is, therefore, well to heap up the earth round the stem and to hollow it out at a distance into circular ditch, so that, when the water is poured in, the tree stands on a small mound surrounded by water. It is better to give water in good quantity at intervals of three or more days than to give smaller supplies daily, as this causes them to send their roots deeper into the soil where the natural moisture is greater, and a more steady growth is the result. The best time for supplying water is the afternoon.

Loosening the surface soil

5. It is important to keep the surface soil for a foot distance all round the trees as loose as possible. A hard crust on the

surface is injurious to the young trees and in particular makes the soil below dry much faster than if the surface is kept loose. Where water is applied direct to the surface of the soil, the ground should be hoed with the khurpi after each watering; where gharas are used, hoeing should be done whenever the surface is getting compact.

Special measures in droughts

6. Special care is needed to secure that irrigation is adequate in seasons of drought. The responsible official must be on the alert throughout the rains, and when a break is prolonged he must take instant measures to secure that the trees are getting enough water. A year's work may often be thrown away by neglect for a very few days at this season.

CHAPTER X

(3) Maintenance—Miscellaneous

General

1. The principal operations employed to maintain young trees are those enumerated in the two preceding chapters, keeping the guards in an efficient state, and regulating the supply of moisture. There are, however, a few other points requiring attention.

Pruning

2. It has been said that it is better not to prune at all than to prune badly, and skill is required for good pruning. This pruning is required in the nursery, during the period of maintenance and during the after-life of the tree. For convenience it is dealt with in Chapter XI.

Straightening crooked trees

3. Much pruning should not be required at the road side if the trees have been carefully tended in the nursery, only the best selected for planting at the road side and only large trees planted as recommended. If small trees are planted occasionally some get a crooked start or are bent by the prevailing wind. In such cases the tree should be straightened by tying the stem to a straight stick. It is not advisable to fix this stick

in the ground close to the stem as the roots of the tree suffer ; it is better to support it by tying to two stakes one on either side of the tree and in the line of the prevailing wind. The tree may be tied to the straight stick at one or more points as needed, but special care must be taken that the bark of the tree is not injured in any way in this process, and the material used for tying should be soft unspun hemp fibre, or some similar substance, and not cord or string.

Replacing failures

4. If a length of road has been planted early in the rainy season, the trees should be examined carefully after three weeks or a month, and any that have not made a good start should be pulled up and replaced by new plants. Where, however, planting has been delayed till late in the season, this course is not practicable, and the failures must be left to be replaced in the next year.

Termination of maintenance

5. When the period of maintenance, prescribed by the plan, is drawing to a close each length of avenue should be carefully inspected to see whether the trees can safely be left to themselves. It may be found that accidents of season or careless work have resulted in the trees being backward : and if there is any reason to think that any considerable number of trees still require attention, arrangements must be made to leave a Mali in charge for another year. If there is no doubt that the trees can be left to themselves, the length of avenue should be classed as established, but the responsible official should visit it occasionally for the first year and, if he sees that the trees are suffering from any cause, he should take measures at once to have them attended to. If there is any doubt whether the trees are established or not, it is safe rule to assume that they need more attention.

Removal of tree-guards

6. It is not necessary to remove the tree-guards immediately avenue is classed as established. This should be done only when the lower branches of the trees are sufficiently high to be out of reach of cattle and goats and the trunks are strong enough to withstand cattle. If this is not the case, any guards except

live hedges should be left standing for a year or two more; live hedges, however, should be destroyed at once as the risk of their growing into rank jungle and injuring the tree is too great to be run.

CHAPTER XI

Management of Avenues

(1) Pruning

General

1. The most important part of this management, after the trees have become self-supporting, will consist of pruning. Thinning will rarely be required as the maintenance of trees at the road side is usually so costly that no more will be planted than are wanted for the avenue.

Pruning

2. The object of pruning is to obtain a shapely healthy tree with shade not over-thick. It should begin in the nursery and continue almost to the end of the life of the tree. It has, therefore, been thought best to deal with it as a whole in this place.

Since the tree must not interfere with the traffic on the road it must have a clear stem free from branches for a certain height from the ground. This height will vary with the conditions and is sometimes given as 8 to 10 feet. If the branches grow horizontally it may be necessary to shorten some of these. But the height of 11 feet to the first branch should not be exceeded. Keeping this height from the ground clear of branches helps the drying of the road after rain and thus reduces to some extent the wear of the road surface.

Forming straight boles in young road-side trees

3. The smaller the branches are when pruned, the less the harm done. The natural tendency of many trees, notably the firs and pines, is to grow with a straight stem and regular conical crown. Other trees, including most of the broad-leaf trees, are most irregular in their growth and naturally have many trunks, or great lateral branches. By the judicious pruning

while young and small, of the lower branches, isolated trees growing along roads may be given tall, straight stems, as if they had been grown in close contact with other trees in a well managed forests.

4. To obtain these conditions, the trees should be pruned while young. The terminal buds of any secondary leading shoots that appear should be pinched off at once ; and the lowest lateral branches should be pruned off each year while they are still small. If the top is weak or broken, it may be cut off and one of the side branches allowed to take the lead.

5. Not more than about two rows or tiers of branches should be removed in one year. If too many of the branches are removed, the health of the tree suffers ; it becomes top heavy and has to be supported. Nor ought the pruning to be commenced too soon before the tree is advanced enough to stand such treatment. The leaves of the branches perform the function of manufacturing nutriment for the tree and their removal too early, or too many at a time, causes the growth of spindly weak stem. In addition the strong sun, falling on young bark, especially if wet, causes it to burn or toughen and the tree consequently becomes hide-bound. The age at which pruning should be commenced and the amount to be pruned depend primarily on the rapidity and vigour of the growth. The regular stems seen in the avenues of European cities are formed by keeping the lower branches pruned while the young trees are still in the nursery. Such trees rarely require much pruning in after-life.

6. Pruning at the road-side will follow the same lines until the stem is clear of branches for the desired height from the ground. After that, except for the removal of broken branches, the pruning will consist of removing superfluous branches with a view to keeping the tree shapely, to prevent it from obstructing the traffic, to reduce the shade when desirable in the interest of economical road maintenance, and sometimes to rid the trees of certain fungus diseases or insect pests.

Axes not to be used in pruning

7. The pruning of road-side trees in this country is generally done by a coolie climbing the tree and hacking off the branch it is wished to remove at six inches or a foot from the stem leaving a jagged, unsightly stump. These snags rot and bring about the quick decay of the tree. All this is avoided by using the saw instead of the axe and by cutting of the branches smoothly

flush with the stem. Such wounds soon heal and become covered with bark. When cutting back lateral branches always cut at a fork. Valuable timber trees are constantly hacked to admit a free circulation of the air, as it is called, and are in consequence rendered useless, except for firewood. There are few stations or road-side avenues where such eye-sores are not to be found. The use of the axe by coolies should be strictly prohibited. Pruning could be done with an axe if sufficient care were taken. But this care is never taken, and the only possible way to prevent hacking is not to allow axes to be used.

8. All prunings should, therefore, be done with the saw or good sharp steel instruments. Small branches or twigs should be cut with a sharp pruning knife, larger branches with the saw or pruning chisel. In removing a large branch first cut through the bark all round with the pruning knife or chisel ; then saw it off roughly about a foot from the trunk, cutting the under side first and afterwards the upper a few inches further from the trunk, and finally saw off the stump : or the pruning chisel may be used first to cut all round the branch before using the saw. In this way there will be no tearing of the bark. After the branch has been removed, any jagged ends left should be pared smooth with the pruning knife, and then the whole cut should be painted over with tar. The cut, where possible, should be vertical, or slant downwards, so that the rain water may not lodge on it or get into the stem through the wound. Where the wound is necessarily large, it should always be covered with tar to protect it against moisture and decay.

Season for pruning

9. The end of the cold weather, just before the leaves appear, when growth is least active, is the best season for pruning, as the wounds are then left exposed for the shortest time possible. If done during winter, they remain uncovered too long ; if during the warm weather, when the trees are in full growth, the wounds bleed, and tar, if used, will not adhere to them.

(2) LOPPING

Lopping

10. Lopping, by which is meant cutting of the branches only, should be done carefully and extremely moderately when it is necessary (*a*) for promoting growth of the trees or (*b*) for

improving the symmetry and beauty of an avenue, or (*c*) for keeping the tree shapely or (*d*) for preventing the branches from obstructing the traffic, or (*e*) for getting the tree rid of certain fungus diseases or insect pests. It is also desirable in the interest of economical road maintenance to reduce the overhanging branches of trees, but the necessary check should be exercised on the lopping done for this purpose so as not, virtually, to spoil the trees or at any rate to create the most inaesthetic effort. Proper season for lopping is the winter, when the sap is down.

(3) Tree Surgery

11. The tree becomes prey to many enemies. These include the untrained worker who prunes the tree or lops the branches for any *bona fide* purpose. The storms, and cyclones also play their part and damage trees in many ways. The insect pests and diseases also get hold of the open wounds on trees and settle down comfortably to breed or multiply.

12. The tree injury has to be dressed in time to prevent this rot which destroys the tree completely in the long run, and also spreads infection to other likely places in an avenue or stray trees.

13. There are two established methods of treatment. One is preventive and the other is curative. The preventive measures consists of cutting the branches or broken limbs with a sharp saw or chisel, flush with the main limb, and dress the cut portion with tar or paint or any other wood preservative. While cutting the unwanted branches, care must be taken to take a primary cut one or two inches deep in the bark on the lower side of the branch or stump which is required to be cut. This prevents peeling or tearing of the lower bark on the limb before it is completely removed. The irregular longitudinal slits in the lower bark sometimes extend down below and injure the main trunk also.

14. In the curative process the rotting limb has to be further pruned or scrapped till live cambium layer and fresh wood are obtained. Then if there is a cavity, it has to be filled up with asphalt, cement mortar, bricks or even stone masonry after disinfecting the fresh portion of the newly made wound. The nature of filling material usually depends on the magnitude, suitability of operation and availability of the materials.

15. The ultimate object in both the above mentioned processes is to help the natural formation of bark and callus over the wound wherever feasible by preventing the wound from rotting due to one cause or the other, and weaken the tree, and also to support the weakened limbs by artificial reinforcement.

16. The typical injuries and methods employed to heal or cure them are illustrated, *vide* plate IV.

17. A watch must be kept over the established avenues, particularly in the neighbourhood of towns to see that branches are not being cut for fodder by camel drivers or goat herds. Trees suffer serious injury owing to the repeated stripping of leaves and young branches that results when the people are allowed to make a free use of them.

(4) Realisation of Income

Source of income

18. The income credited to arboriculture is derived from the following heads :—

(1) sale of fallen trees ;

(2) sale of loppings ;

(3) sale of annual produce of trees ;

(4) sale of road-side grass ;

(5) miscellaneous.

As a general rule whatever has to be sold should be sold by auction.

Lopping

19. Lopping should never be done by the purchaser, as it is hopeless to expect that the work would be properly executed. The superfluous branches must be cut by the men employed on the avenues, and then sold.

Grass

20. The grass on all roads is in some Provinces sold for the benefit of arboriculture, whether there are avenues on the roads or not. Care must be taken that the grass does not fall into the hands of persons who will use their position to levy blackmail on the owners of cattle traversing the road.

Special care is needed on this point in localities where the supply of grazing is so large that there is little demand for the road-side grass. In these cases it may even be better not to sell the grass at all; but where the demand for grass is great, sales should invariably be made as otherwise the unrestricted grazing is likely to result in serious injury to the trees.

Conditions of sale of grass

21. Contracts for the sale of grass must provide (1) that the grass shall either be cut with a sickle or grazed off the road and that the khurpi must not be used; (2) that the contractor is responsible for all damage caused by animals to trees on the roads which he has taken. Where the roads have young trees a penalty of a reasonable sum, as liquidated damages, should be fixed for each tree destroyed during the period of the contract.

CHAPTER XII

GROVES

Encamping grounds

1. Shade should be provided as far as possible on encamping grounds, especially on the roads where there is a large pilgrim traffic. The system of planting should be generally similar to that indicated for avenues, except that as many lines should be planted as there is room for, and that the lines should be the same distance apart as the trees in the line. Trees giving thick shade should be preferred, but the tamarind should not be planted in ordinary circumstances as there is a prejudice against sleeping under it.

Groves on barren roads

2. Endeavours should be made to plant groves of trees at intervals along lengths of road where the soil is barren and avenues cannot be expected to succeed. The need of shade is greater on these roads than anywhere else. The least barren patches of ground on the roadside should be picked out with the assistance of practical cultivators living in the neighbourhood; the presence of Hariali grass almost always indicates a patch of better land. Where a patch appears to be suitable, a hole

should be dug in it to depth of four or five feet and the nature of the sub-soil carefully examined; if it is stiff clay down to five feet, there is little prospect of getting trees to grow, but if loam or sand is met with by that depth there is a good chance of success and the patch may be chosen for operations.

Special methods of planting on barren land

3. The work of planting such patches differs from that indicated in previous chapters in the following respects :—

(1) The holes for trees should be closer together as they will not spread to the same extent : about two-thirds of the distance apart recommended for loam is a fair general rule.

(2) The holes should be dug down to the loam or sand; the clay taken out of them should not be returned, but should be thrown aside and the holes should be filled with good loam obtained from a better part of the roadside, or (on payment) from an adjoining field.

(3) Special attention is needed to see that the trees are not exposed to the danger of water-logging, as these barren tracts frequently tend to become swampy in the rains.

(4) More frequent irrigation and tillage of the surface will probably be necessary.

(5) No attempt should be made to grow delicate trees; hardy trees such as the nim are the likeliest to succeed.

(6) If the road is not well supplied with water, a masonry well should be sunk among the trees if any pious person can be induced to confer this benefit on the public : a well with a clump of even half a dozen trees giving a little shade will be sure of the cordial appreciation of travellers.

(7) It will be obvious that the planting of clumps of trees on barren road-sides will cost more than the same number of trees on fertile soil, so that when there is much planting to be done on loam it should have the preference; but, where most of the unplanted roads are on barren soil, endeavours should be made to provide a certain amount of shade on them as suggested above.

CHAPTER XIII

Planting by Private Persons

1. Every encouragement should be given to private persons who may be willing to plant trees on public roads at their own expense. The following rules have been laid down to regulate such planting on roads under the District Local Board :—

Permission to plant

(1) No private person shall be allowed to plant trees unless he obtains written permission to do so from the President of the District Local Board.

Conditions

(2) In applying for permission the person who wishes to plant must consent in writing to abide by the following conditions :—

(i) Only trees of a kind or kinds approved and specified by the President shall be planted.

(ii) The planting shall not be done by seed, or by seedlings of less than two years' growth.

(iii) The trees shall be planted in regular lines, and at such distance from each other and from the middle of the roadway as the President may prescribe.

(iv) The planter shall provide for the irrigation and protection of the trees until they grow sufficiently large to need no more attention.

(v) The trees will be the property of the person who plants them and his successors ; but he will not have power to lop or fell without the permission of the President, and he will have no claim to the land on which the trees stand. He will, however, be entitled to take the fruit and all dry or fallen wood, as well as all loppings made in the ordinary course of arboricultural operations.

(vi) On planting a tree the planter shall give intimation to the Mamlatdar concerned, specifying the kind of tree planted and its position.

(3) All permission to plant that may be granted by the President shall be intimated to the Mamlatdar concerned. The Mamlatdar shall keep a list of such permissions and shall compare it from time to time with the register which is maintained as prescribed below, reporting to the President any cases in which permission to plant has not been taken advantage of within three years.

Grant of sanad

(4) When trees planted under the preceding rules have grown sufficiently to be no longer in need of irrigation or protection, the planter shall be entitled to obtain from the President a sanad declaring his ownership of the trees and setting forth the conditions under which they were planted. Sanads will be issued through the Mamlatdars concerned and will be made out in the form given in Appendix G.

2. The provisions in the last paragraph apply only to district roads. The Superintending Engineer will decide whether private persons can be allowed to plant trees on provincial roads. When permission is given, the procedure laid down in the last paragraph should be followed generally.

Register of trees planted

3. A new register will be opened in each taluka in the form given in Appendix F at the end of this manual, a suitable number of pages being allotted to each road on which private planting has been permitted. Entries will be made in this register on receipt of reports from planters under conditions (2) (*vi*) above; the reports will first be verified under the orders of the Mamlatdar who will sign each entry below the date in column 9.

Testing

4. The entries of previous years will be tested on the spot from time to time under the orders of the Mamlatdar; if any trees entered in the register are found to have died or disappeared, they will be struck out from the register under the Mamlatdar's signature.

Register of Provincial roads

5. A similar register should be maintained by the Executive Engineer for provincial roads where permission to plant has been given under paragraph 2.

CHAPTER XIV

(1) Selection of Trees for Avenues

1. The objects to be aimed at in choosing trees for roadside avenues are the following :—

(1) Provision of shade for travellers.

(2) Improvement of the landscape.

(3) Addition to the food-supply of the people.

(4) Provision of a fodder-reserve in famines.

These objects are stated in the order of their importance and should be carefully considered when operations are being planned. As an exception, the third and fourth objects may be disregarded in planting roads in the immediate neighbourhood of civil stations and large towns. In the case of station and town roads the importance of even the first object is diminished.

2. The best general principle to follow is to select trees of those kinds which are found growing under similar conditions in the district, and which best fulfil the objects stated in the last paragraph. Many trees which yield a supply of food or other produce, are good shade trees and also handsome, so that it is possible, by the exercise of a little care, to secure, in many cases, almost all the objects which are desired. Advice, when required, may be obtained from the Forest Officers, in the case of forest trees of the tract or, in the case of other trees and ornamental avenues, from the Director of Parks and Gardens.

3. As a rule, the trees in the same length of avenue should be of the same kind. If the trees are uniform in look and growth the effect is excellent and a much better price can usually be obtained for the produce where all trees of the same kind are together. But for general planting trees should

be selected which are known to grow well in the vicinity or in similar localities. It is of course desirable to introduce new kinds which are useful or ornamental, but, where the success of the experiment is doubtful, it should be tried on a small scale. Deep-rooted and hardwood trees may be planted in exposed situation in preference to shallow-rooted and soft ones.

4. A list of trees which are more or less suitable for avenues is given below. Information as full as is available is given for each, but it must be remembered that local conditions may render this information incorrect and it will be for the Officers in charge of operations to note such cases. The distances shown are for trees planted on average soil. If the soil is rocky the distance should be reduced by five feet and if the soil is deep and fertile the distance should be increased by five feet.

(2) List of Trees

E. English, H. Hindi, M. Marathi, G. Gujarati, K. Kannad.

1. *Acacia arabica.* E. Babul; H. Babul; M. Bhabhul; G. Baval; K. Karijali.

A small thorny tree with many small branches and small bluish green leaves. Bark dark brown and rough. It bears leaves and pods are greatly relished by goats. Unripe pods yellow globular flowers about ½″ diam. and pods 6″ long. The are used in the preparation of ink. Seeds excreted by goats grow easily otherwise they have to be soaked for some days in cowdung water before sowing. The tree produces the common gum arabica. The wood is tough, close grained and durable and is used for cart wheels etc. However, the wood is mostly used for fuel. The bark is used for tanning. This tree is unsuitable for roadsides on account of its thorns but it may be planted along canals. Distance apart 30 feet.

2. *Acacia moniformis.* E. Australia Babul.

A graceful medium sized evergreen tree with slightly droping branches and greyish brown bark. The narrow bright green leathery leaves are scattered along slender twigs.

It bears yellow spikes of flowers in loose bunches near the ends of the twigs. The pods are flat and twisted. Flowers September to October. Easily grown from seed. Distance apart 30 feet.

3. *Acrocarpus fraxinifolius* E. Shingle tree.

A large deciduous tree with bipinnate leaves and fairly smooth greyish brown bark. The small red flowers are borne in dense clusters. The pods are strap shaped. The wood is fairly hard and used for boxes etc. Grown from seed. Distance apart 50 feet.

4. *Adenanthera pavonina.* E. Red Sandalwood; H. Rakta-chandana; M. Gunj.

A medium sized deciduous tree with pinnate opposite leaves and dark grey bark.

Flowers small, yellowish and scented. Pods long and twisted when opening. The bright scarlet shining seeds are used by jewelers and goldsmiths as measures of four grains weight. The wood is hard and red and is useful for cabinet making. Grown from seed. Distance apart 30-40 feet.

5. *Aegle marmelos.* E. Bael; H. Bel; M. Bel; G. Bili; K. Bel.

A medium sized deciduous tree with grey bark. Branches armed with long spines, leaves trifoliate flowers greenish white, sweet scented, fruit smooth orange yellow, spherical or elongated 3″ to 6″ diam. with thin tough woody shell. The seeds are embedded in orange coloured pulp which has great medical value and is specially used to secure deysectry. The fruit is also used for making *sherbat.* The bark and leaves are used in medicine. The tree is considered sacred by Hindus. Grown from seed. Distance apart 40 feet.

6. *Ailanthus excelsa.* H. Mahaneem; M. Maharukh; G. Moto Arduso; K. Dodumani.

A tall deciduous quick growing tree with large greyish green pinnate leaves and rough light brown bark. Flowers small yellowish. Pods flat and papery. The wood is soft white and light but fairly strong. Used for various purposes where lightness is needed. Grown from seed. Distance apart 40-50 feet.

7. *Albizzia lebek.* E. Black siris; H. Siris; M. Shirus; G. Sarasdo; K. Sirsal.

A large spreading hardy deciduous tree with brownish grey bark. Its leaves are divided into a number of blunt unequal sided leaflets. The flowers are borne on the tips of the branches in the hot season. New leaves also appear at this time.

From February to May the tree is covered with long flat straw coloured pods. The wood is hard, seasons well and is used for furniture, building etc. Easily grown from seed. Distance apart 40-50 feet.

8. *Albizzia procera.* E. White Siris; H. Safed Siris; M. Kinai; G. Dholo Sarasdo.

A large deciduous quick growing tree with a long clean bole and whitish or pale grey bark. Leaves similar to A. lebek bright green above and pale underneath. The whitish green flowers are borne in small spherical beads in open clusters at the ends of the branches. The pods are narrow, flat and brown when ripe. The wood is straight-grained, hard and durable. Used for bridges, houseposts, implements etc. Grown from seed. Distance apart 40-50 feet.

9. *Alstonia Scholaris.* E. Devil's Tree; H. Chatiun; M. Satvin; K. Hale.

A large evergreen tree with dark brown bark and branches usually arranged in whorls. The leaves are smooth shining dark green above and whitish below. Flowers are small, greenish white, sweet scented, and borne in clusters from October to December. The wood is light and soft and not very durable. It is used for making boxes, blackboards etc. Grown from seed. Distance apart 45 feet.

10. *Anacardium occidentale.* E. Cashew; H. Hijjali badam; M. Caju; G. Caju; K. Kachumak.

A small tree with bright green leathery leaves and brown bark. The leaves give a pleasant smell when crushed. The flowers are greenish and sweet scented. The fruit which is really the enlarged stalk is brightly coloured yellow or crimson. Juice extracted from the fruit is used in distillation. The nut which is the real fruit is borne outside. Grown from seed. This tree is more suitable for Parks and Gardens than for the roadside. Distance apart 30 feet.

11. *Artocarpus integrifolia.* E. Jack Tree; H. Kathal; M. Phanas; G. Phanas.

A medium sized evergreen tree with dark green shining foilage and a thick trunk with dark brown warty bark. Flowers insignificant sweet scented. Fruit large cylindrical greenish with rough surface. It contains many kidney shaped seeds,

each embedded in soft pulp which is eaten and is much esteemed. The fruit has a very strong sweetish smell when ripe. The wood is yellow and used in cabinet making, building etc. Grown from seed which must be sown fresh, singly in pots as they do not transplant well. Distance apart 40 feet.

12. *Azadirachta indica.* E. Indian Lilac nim; M. Balant Nimb; G. Limdo; K. Bevinamar.

A large graceful hardy evergreen tree with rough brown bark and delicate foliage. The small white sweet scented flowers are borne in great abundance in loose clusters. The flowers and new leaves appear in March when the branches are almost bare of foliage. The fruit is a small yellow berry containing a single seed set in a juicy pulp and yields an oil which is very valuable in medicine and soap making. The leaves are bitter but are eaten by cattle. The timber is hard close grained and durable as is used for ship-building, agricultural impliments, furniture etc. Grown from seed. Distance apart 40 feet.

13. *Barringtonia racemosa.* E. Indian Oak; H. Hijjal; M. Mankumbh; G. Samuda Phal; K. Kempukanjin.

A stout middle sized evergreen tree with greyish brown bark. Leaves large and clustered near the ends of the branches. The flowers are cream coloured with pink stamens and are borne in long pendulous spikes with the flowers facing downwards. Fruits are large and egg shaped each containing a single seed. The wood is used as firewood. Grown from seed. Distance apart 40 feet.

14. *Bassia Latifolia.* E. Mohwra; H. Mohwa; M. Madhuk; G. Mahudo; K. Ippemar.

A large hardy decidouous tree with fairly smooth ash-coloured bark. The leaves are large and leathery and are clustered near the ends of the twigs. The new tender leaves are a bright russet colour. The white fleshy cup shaped flowers have a peculiar scent, and are eaten. Dried flowers are used for distillation. The fruit is oval about 1" diameter and contains a single seed. A butterlike grease is obtained from the seed which is used for soap making and as an adulterant of ghee. The wood is hard and is used for furniture, cart wheels etc. Grown from seed. Distance apart 35-45 feet.

15. *Bauhinia pupurea.* E. Camel's Foot Tree; H. Kachnar; M. Kanchan; G. Krishnavali; K. Kempumandar.

A medium sized evergreen tree with brown bark and leathery leaves which are cleft into two lobes giving them a camel-foot shape. The large showy fragrant flowers are borne in loose clusters at the ends of the branches in November and December. The pods are long narrow and flat. They burst when drying and throw the seeds to a distance. The wood is fairly hard and is used for making impliments. Grows from seeds. Distance apart 35 feet.

16. *Bauchinia Variegata.* E. Camel's Foot Tree; H. Kachnar; M. Kanchan; G. Krishnavali; K. Kempumandar.

A small tree resembling B. pupurea but is deciduous for a short time in January or February when the flowers appear. The large purple, pink or white flowers almost cover the branches making the tree a beautiful sight. The bark is used for medicinal purposes. Grown from seed. Distance apart 30-35 feet.

17. *Bombax malabaricum.* E. Red Silk Cotton tree; H. Simal; M. Lal Sanwar; G. Simro; K. Elar.

A large tall stately deciduous tree with stout comical prickles. The under bark is deep red in colour. The branches are more or less horizontal. The leaves are digitate with five to seven leaflets. The leaves fall in February when the tree gets covered with large crimson flowers which drop down causing much litter. The pods burst in May scattering the silk cotton which is blown about. The wood is light and soft and is much used for packing cases, canoes, lining wells etc. It also makes good charcoal. Grown from seed. Distance apart 50 feet.

18. *Brownea grandiceps.* E. Rose of Venezuela.

A small evergreen tree with pinnate leaves and pointed leaflets. The young leaves are enclosed in pinkish scales which drop off and the leaves hang limp from the ends of the branches. They are first purplish and then become glossy green. The scarlet flowers are borne in bunches on the under sides of the small branches. The pods are flat and curved. Flowers appear in February and March also sometimes in September. Grown from seed. Distance apart 30 feet.

19. *Butea monosperma* (*frondosa*). E. Flame of Forest; H. Dhak; M. Palas; G. Khakhro; K. Muttale.

A medium sized deciduous tree with gnarled trunk and large coarse dark greyish leaves. It bears profuse clusters of orange red flowers in February March when the leaves have fallen. A tree in full flower is a gorgeous sight. The pods are broad and flat, thickened at one end each pod bearing one seed. The leaves are used as plates and the flowers produce a yellow dye. The wood is soft and used for making charcoal. Grown from seed which should be sown in pots as the plants do not stand transplanting wall. Distance apart 30 feet.

20. *Caesalpina coriaria*. E. Divi-divi; M. Divi-Deevi; K. Aldekai.

A low tree with spreading branches and rough grey brown bark. The minute leaflets are dark green above and greyish below. The small yellowish green sweet scented flowers are borne in dense clusters at the ends of the branches. The thick brown twisted pods are valuable for tanning and also for the preparation of ink. The pods and bark are used in medicine. The wood is hard and heavy. Grown from seed. Distance apart 30 feet.

21. *Calophyllum inophyllum*. E. Alenxandrias Laurd; H. Sultan Champa; M. Undal; G. Udan.

A handsome medium sized evergreen tree with smooth greyish black bark and dark green thick shinning leaves. It grows well on the sea coast. It bears pretty white fragrant flowers resembling orange blossoms. The fruit is spherical about 1½" diam. bearing a sigle seed. Oil is entracted from the seeds. The wood is close-grained and fairly hard and is used in cabinet making etc. The tree flowers from May to December. Grown from seed. Distance apart 35 feet.

22. *Cassia fistula*. E. Indian Laburrium; M. Bahava; G. Garmars; K. Kakke.

Called the Indian laburnam. A hardy medium sized deciduous tree with light brown bark. The leaves fall in the beginning of the hot season and in April the tree is covered with large bright yellow flowers which hang in loose bunches. The fresh leaves appear together with or just after the flowers. The pods are about two feet long, cylindrical and dark choco-

late brown in colour. The pulp is a purgative. The wood is used in agricultural impliments Grown from seed. Distance apart 40 feet.

23. *Cassia gracilis*. E. Horse Cassia.

A small or medium sized deciduous spreading tree with fairly smooth grey bark. The leaflets are narrow and reddish when young and dark russet green when mature. A profusion of lilac pink flowers are borne in bunches in April when the leaves have fallen. The pods are thick cylindrical and about nine inches long. The pulp of the pods is a purgative. The wood is not very useful. Grown from seed. Distance apart 35 feet.

24. *Cassia Javanica*. E. Java Cassia.

A beautiful small deciduous tree with fairly smooth brown bark. The narrow blunt leaflets are bright green in colour. The bright pink flowers are borne in clusters on short leaflets branches. The pods are dark brown long and cylindrical. The flowers are borne in April and May and new leaves are produced about the same time. The tree is useful medicinally. The wood is not very useful. Grown from seed. Distance apart 35 feet.

25. *Cassia marginate*. E. Red Cassia.

Red cassia (sym. C Rox burghi) A small graceful tree with cracked brown bark. Branches spreading and somewhat dropping. The leaves are more slender than the other cassias. The small fragrant cerise or terra-cotta flowers are profusely borne in narrow clusters among the leaves and remain on the tree longer than the other cassias. It flowers from May to July. The pod is long, smooth and cylindrical. The wood is used for wheels and handles. Grown from seed. Distance apart 35 feet.

26. *Cassia renigera*. E. Burmese Pink Cassia.

A small graceful spreading deciduous tree with brownish grey bark. The pink scented flowers are borne in April and May in short bunches along the bare branches. It resembles C. Javanica. The fresh leaves appear together with or soon after the flowers. The pod is long cylindrical and brownish black in colour. The wood is not very useful. Grown from seed. Distance apart 35 feet.

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27. *Casuarina equisetiflia.* E. Casuarina; H. Vilayati Saru.

A large evergreen tree with dropping slender branches and long needle like leaves. There are separate male and female trees. The flowers are inconspicuous. The female tree bears small woody globular cones. These trees give scenty shade. The wood is hard and makes good beams and posts. It is much used for fuel in South India. The bark is dark brown and is used for tanning. Grown from seed. Distance apart 40 feet.

28. *Chrysophyllum cainito.* E. Star Apple.

Star apple. A compast evergreen medium sized tree with dark green leaves which are golden underneath and the bark brown. The flowers are small purplish white. The purplish coloured fruit is smooth globular and about the size of an apple, the core being star shaped. The pulp is eaten. Grown from seed. Distance 40 feet.

29. *Cochlospermum gossypium.* E. Buttercup tree; H. Pili Kapas; M. Galgal.

A medium sized deciduous tree with stout branches and light coloured bark marked with furrows. The leaves which are borne on long stalks towards the ends of the branches, fall in January and for a few months the branches remain bare. The large bright yellow flowers appear in March April in clusters at the ends of the bare twigs giving the tree a very striking effect. The fruit is a large pear shaped pendulous capsule. To each seed is attached a quantity of pure white silky floss which is used for stuffing pillows. The gum from the bark is useful. The wood is very soft and used for torches. Grown from seed. Distance apart 40 feet.

30. *Colvillea racemosa.* E. Colville's Glory.

A handsome medium sized deciduous tree with pinkish or coppery bark. It resembles the gulmoha when not in flower the feathery leaves being larger than those of gulmohr. The leaves are shed in the beginning of the hot season and the new leaves appear in May. The flowers which are orange in colour are borne in dense conelike spiked which hang in clusters from the tips of the branches. The tree flowers in August-September when there are few other trees in flower. The pods are flat, about 7″ long. Grown from seed. Distance apart 40 feet.

31. *Couropita guianensis.* E. Canon ball tree; H. Shivlingan.

E. Cannon ball tree. A tall evergreen tree with narrow pointed leaves clustering round the ends of branches. Flowers are borne in loose bunches on leafless twigs springing from the trunk. The flowers which are about 3" across with curved petals are a pleasing mixture of yellow white and pink. The fruit is brown, large spherical and hard containing a cream coloured pulp. Flowers appear throughout the hot season. The timber has a bad smell and is not useful. Grown from seed. Distance apart 40 feet.

32. *Dalbergia latifolia.* E. Indian rosewood; H. Bilayati shisham.

A medium sized deciduous tree with grey bark which peels off in flakes. The leaflets are roundish with blunt ends and are arranged alternately. The small whitish flowers grow in short branching clusters among the leaves. The pods are flat and brown about 3" long, each usually containing two seeds. The new leaves appear in the hot weather. The purple black wood is valuable and is much used for making furniture being hard and close grained but easily worked. Grown from seed. Distance apart 40 feet.

33. *Dalbergia Lancaolaria.* H. Takoli.

A tall graceful deciduous tree with rather dropping branches and smooth grey bark which peels off in patches. The leaflets are bright green narrow at the base and rounded at the tip. The small mauve coloured flowers are borne in profusion in clusters at the ends of the twigs. The pods are brown, flat and pointed. Fev leaves and flowers are produced in May. The wood is white and not durable. Grown from seed. Distance apart 40 feet.

34. *Dolbergia Sissoo.* E. South Indian Redwood; H. Shisham.

A large deciduous tree with rough grey bark which peels off in strips. The leaflets are roundish with pronounced points and are arranged alternately. The flowers are small yellowish white sweet scented and borne in short branching clusters. The pod is thin and pale brown and is blown about by the breeze. The wood is hard close grained, durable and seasons well. It is extensively used for furniture, boat building etc. and is considered to be the finest of Indian timbers for carving. The leaves fall in the cold season and are soon replaced by new ones which are quickly followed by the flowers. Grown from seed. Distance apart 40 feet.

35. *Erythrina indica.* E. Coral tree; H. Pharad; M. Paranga, G. Pandarvo; K. Halivan.

A medium sized deciduous tree with light green foliage and light yelowish grey smooth bark which peels off in thin papery flakes. The branches are armed with conical black prickles. The leaves are shed in the cold season and the tree remains bare till the flowers appear in February March. The leaves appear sometime later. The bright scarlet showy flowers are borne in dense tufts at the ends of the stems. The pod is long and round with distinct joints between the seeds. The wood is very light and soft but fairly tough and is used for boxes etc. There is also a white flowered variety and one with variegated leaves. Easily grown from cuttings. Distance apart 35 feet.

36. *Eucalytus rostrata.* E. Red gum tree.

A tall quick growing evergreen tree with greyish green long narrow pointed leathery leaves and dark grey trunk. The stalks of young leaves and twigs are reddish. This is a hardy drought resisting variety of eucalyptus. The flowers are small greenish coloured and borne in clusters in the axils of the leaves. The seeds are enclosed in small woody capsules. The wood is light coloured hard and close grained and is used in coach building etc. The gum is red. Grown from seed. Distance apart 35 feet.

37. *Eucalyptus teriticornis.* E. Eucalyptus; M. Nilgiri.

It is similar to E. Rostrata but more erect growing with broader leaves larger capsules and grey gum. It is quick growing hard and drought resisting. Grown from seed. Distance apart 30 feet.

38. *Eugenia Jambolana.* E. Java plum; H. Jaman.

A handsome large evergreen tree with oval leathery shining leaves and light grey bark. The small fragrant whitish flowers are borne in clusters in the hot season. The fruits which ripen in May June vary in size and shape and are almost black when ripe. Each bears a simple seed set in juicy pink pulp. Good cultivated varieties yield a fruit which is much eaten and fetches a good price. An alcoholic drink is prepared from the juice. The wood is reddish brown fairly hard and durable and is used for building, agricultural implements etc. The bark is used for tanning and dying. Grown from seed. Distance apart 45 feet.

39. *Feronia elephantum.* E. Wood apple; H. Kavitha; G. Kothu; K. Beldemer.

E. wood-apple : A middle sized hardy evergreen tree with a straight trunk, dark grey bark and small dark green shining leaflets. The small greenish flowers are borne in short clusters. The spherical grey fruit 3″ to 5″ diam. give the tree an ornamental effect. The pulp which is brown when ripe has a strong smell. It is eaten and used in making Jelly. The wood is hard and useful for building, cart making etc. Flowers appear in March and the fruits ripen in October. Grown from seed. Distance apart 35 feet.

40. *Ficus bengalensis.* E. banyan; H. Bar; G. Vad; K. Alad.

A large practically evergreen tree with glossy dark green leathery leaves and spreading branches which send down aerial roots to the ground. When these roots have obtained a footing in the earth they form additional trunks. The leaves are good for fodder. The bright red fruit (figs) are eaten by birds. The seeds often germinate on other trees or on the walls of buildings when it damages the masonry. The wood is of little value. Usually grown from large cuttings 8 to 10 feet high planted in the hot season. Distance apart 50 to 60 feet.

41. *Ficus Benjamina.* E. Java fig.

A large graceful spreading evergreen tree with dark green oval shining leaves dropping branches and light grey smooth bark. The fruits are small orange coloured figs. The branches sometimes produce a few aeriel roots. The wood is not very useful. Grown from cuttings. Distance apart 50 feet.

42. *Ficus glomerata.* E. Monkey fig; H. Gular; G. Umbro; K. Attimav.

A medium sized practically evergreen tree with greyish green leaves and greyish brown bark. It is the common or wild fig. It has a milky juice from which bird lime is prepared. The leaves and bark as well as the galls that grow on the leaves are used in medicine. The figs which are eaten but which are very inferior to the garden fig are borne in clusters along the branches and even on the trunk. Its leaves are used as fodder. Grown from seed. Distance apart 40 to 45 feet.

43. *Ficus Krishnae.*

This is supposed to be a variety of Ficus bengalensis but the leaves are doubled near the base to form a cup. It is not so strong growing and the aerial roots are less freely produced. There is a legend that the God Krishna transformed these leaves into cups for drinking. Grown from cuttings. Distance apart 45 feet.

44. *Ficus religiosa*. E. Peepul; H. Pipal; G. Piplo; K. Arrli.

A well known large spreading tree with smooth pale greyish bark. The leaves are broad with long points and have long slender stalks so that they tremble with every breath of air and are constantly flickering. The seeds are carried by birds and germinate on other trees as well as on walls of buildings. In the latter case they do much damage. Being sacred it is not lapped or felled by Hindus. It does not give much shade and is not very good for avenues. The wood is very inferior. Distance apart 45 to 50 feet.

45. Ficus tsiela. H. Pipri.

A fine large hardy spreading evergreen tree with oval leaves and smooth greyish bark. It is largely used for avenues in the drier districts and will grow where it is difficult to establish other large trees. The fruits are small whitish or purplish. The wood is worthless except for fuel. Grown from cuttings. Distance apart 45 feet.

46. *Filicium decipens*. E. ferntree; H. Katu.

A handsome medium sized compact evergreen tree with dark green fernlike shining leaves and blackish bark. It is rather slow growing. Flowers minute. Fruit a small egg shaped purple berry containing one seed. The wood is hard and strong and useful for building. Grown from cuttings. Distance apart 35 to 40 feet.

47. *Carcina cowa*. E. Cowa mangosteen.

A tall slender tree with pointed shining leaves grey bark and dropping branches. The leaves are dark green below and reddish above. The male and female flowers are borne on the same plants, the male flowers being smaller and in denser clusters, yellow or reddish yellow in colour. The fruit is a reddish berry about 2″ diam. slightly lobed with a depression at the top. It is edible but not palatable. Flowers appear in March and the fruits ripen in May June. A yellow dye is made from the bark. The wood though hard is not durable Grown from seed. Distance apart 35 feet.

48. *Garcina mongostana*. E. mangosteen.

A small tree with large leathery leaves. It bears male and female flowers. The former are purple or red about 1½″ diam.

The fruit is fleshy about 2½" diam. dark purple in colour. It is considered to be one of the most delicious of fruits. Distance apart 30 feet.

49. *Gliricida maculata.* E. Madura shade tree.

A small deciduous tree with long slender branches and graceful leaves which are divided into pointed leaflets which are deep green above and greyish below. The mature bark is grey but that on young branches brownish with white spots. The leaves fall in the cold season and in February the tree is covered with pretty mauve flowers which are borne in dense clusters. It is a quick growing tree but the branches are very brittle. The leaves are not eaten by cattle. Grown easily from seed or cuttings. Distance apart 20-30 feet.

50. *Jacaranda mimosifolia.* E. Mimosa leaved Jacaranda.

A graceful medium sized deciduous tree with leaves resembling those of gul mohr but with smaller leaflets. The bark is smooth and pale grey. The pretty blue flowers are borne in large loose sprays at the ends of the branches in March-April. The fruit is round flat woody capsule. The wood is scented and streaked with purple and black. The tree is rather slow growing. Grown from seed. Distance apart 35 to 40 feet.

51. *Kigelia pinnata.* E. Sausage tree.

A large handsome spreading tree with stiff leaves and large dull maroon coloured flowers which hang down in candelabrum like clusters. They have an unpleasant smell and attract flies. The large sausage like grey fruits hang on long stalks and contain many seeds set in a fibrous pup. It causes a lot of litter when the leaves drop in January or February but the tree is quickly covered with new leaves. The bark is smooth grey black. The wood is hard and of good quantity. Grown from seed. Distance apart 50 feet.

52. *Kleinhovia Hospita.* E. Tree antigonon.

A medium sized tree with roundish crown and pale brown bark. The leaves are oval or heart shaped and borne on long stalks. It bears small pink flowers in large loose bunches at the ends of the branches from August to October when the tree is covered over with blossom. The fruit is a hollow papery bladder. The wood is white and soft. Grown from seed. Distance apart 35 feet.

53. *Lagerstroemia. Flos—Reginae.* E. Queen flower; H. Jarul; K. Marnvathal.

A medium sized deciduous tree with longish leaves and smooth greyish bark which peels off in irregular flakes. The large beautiful lilac or pudplish flowers are borne in stiff open clusters at the ends of the branches. The fruit is a small woody egg-shaped pod containing a number of winged seed. The wood is light red hard strong and durable and used for boat making. It is an important timber tree in Bengal. New leaves appear in March-April and the flowers in April and June. Grown from seed or cuttings. Distance apart 35 feet.

54. *Mangifera indica.* E. Mango; H. Am; M. Amba; G. Ambo; K. Mau.

A large shady evergreen tree with spreading branches and rough blackish bark. The leaves are long narrow leathery and pointed. The greenish or purplish sweet scented flowers are borne in bunches at the ends of the branches in the cold season and the fruit ripens, in the hot season. It is one of the most valuable fruits in India. The tree succeeds where the water level is not at a great depth below the surface. The wood is used for planking door and window frames etc. It is readily eaten by insects. When grown for fruit it is propagated by grafting but for roadside planting it is better grown from seed as those plants are stronger and longer lived. It is better to rear the plants in pots as thereby they suffer less when transplanting. Distance apart 45 feet.

55. *Melaleuca leucadendron.* E. White bottle brush; H. Kayaputi.

A medium sized evergreen tree with narrow leathery dark green leaves and whitish bark which peels off in papery flakes. The small whitish flowers are borne in cylindrical spikes resembling bottle brushes. The leaves are strongly scented when crushed and yield the cajuput oil which is used in medicine. The seed is minute and does not germinate easily but seedlings grow up around the tree. Distance apart 40 feet.

56. *Melia Azederach.* E. Persian lilac; H. Bakayan; G. Bakan nimbdo; K. Buhudbevin.

A graceful quick growing medium sized deciduous tree with small narrow pointed leaflets and greyish brown bark. The small lilac coloured scented flowers are borne in loose branches

clusters which are often partly hidden by the foliage. The fruit is a small oval shining yellow berry containing a simple seed. The flowers and new leaves appear in March. The leaves bark and fruit are used in medicine. The branches are rather brittle. Grown from seed. Distance apart 35 feet.

57. *Michelia champaca.* E. Golden champa; H. Champa; K. Sumpje.

A samll tree with handsome foliage and smooth grey bark. The leaves are about 8″ long and pointed. The large sweet scented orange coloured flowers are borne singly. They fetch a good price in the market. The tree is not very hardy and is rather difficult to establish in dry climates. The small round greenish spotted fruit are borne in clusters. The bright red-seeds drop out when the fruit bursts. A scented oil is obtained from the flowers which also yield a yellow dye. The wood is soft but durable and is used for furniture, planking etc. The flowers appear throughout the hot weather and rains. Grown from seed. Distance apart 25 to 35 feet.

58. *Millingtonia hortensis.* E. Indian cork tree; Ver. akasnim.

E. Indian cork tree. A tall stately erect growing evergreen tree with a straight trunk and thick yellowish white bark. The leaflets are broad but pointed. The long white tubular sweet scented flowers are borne in November-December in large open sprays at the ends of the branches. The flowers drop to the ground forming a white sweet scented carpet. The tree rarely produces seed. The wood is soft yellowish white and resembles pine wood. The tree is grown from root cuttings or suckers which are freely produced. Distance apart 30 to 35 feet.

59. *Mimosops Elengi.* E. Indian medler; H. Bakul; M. Oweli; G. Borsali; K. Bakul.

A fairly large handsome evergreen tree with pretty dark green shining leathery leaves and a straight trunk with dark grey bark. It bears small dull white stary sweet scented flowers which drop to the ground. The fruit is a small orange shining berry containing a single seed in a juicy pulp. It is eaten by poor people. The flowers retain their scent even when dry and a perfume can be made from them. The leaves are useful for making festoons for house decoration. The bark can be used for tanning. The wood is hard and close grained and

useful for carts furniture building etc. Grown from seed. Distance apart 30 to 40 feet.

60. *Mimosops hexandra.* H. Khinni; G. Rayan.

A fairly large hardy evergreen tree with stiff branches and dark green leathery shining leaves resembling those of bakul but smaller and more rounded. It bears small yellow berries each containing one or two black seeds. Fresh fruit as well as dried fruit is sold in the market. The straight shoots can be made into walking sticks. The wood is hard and similar to that of bakul. Grown from seed. Distance apart 40 feet.

61. *Ochrocarpus longifolius.* H. Suringi.

A medium sized evergreen tree with large oblong leathery shining leaves and smooth dark grey bark. The leaves are dark green above and much smaller and marked with veins on the underside. The small rose coloured or red stiped fragrant flowers are borne in small clusters on the small branches. The fruit resembles an acorn and encloses one or more seeds in a pulpy juice. The wood is red, evergrained and hard and is used for planking. Grown from seed. Distance apart 35 feet.

62. *Parkia biglandulosa.*

A large tree with compound bipinnate leaves spreading branches and light grey smooth bark. The leaflets are very small and light green in colour. The flowers are small and borne in compact round heads at the ends of the branches. The pods are long and flattened. It is a quick growing tree. The wood is soft and used for boxes etc. Grown from seed. Distance apart 45 feet.

63. *Pettophorum ferrugineum.* E. Yellow gold mohur.

A large handsome evergreen tree with elegant dark green foliage and smooth grey bark. The bigsinnate leaves are divided into small leaflets. The midribs and young stems are covered with rusty coloured down. The beautiful yellow scented flowers are borne in large stiff sprays at the ends of the branches. The flowers chiefly appear from March to May and a second flowering occurs in September. The sap wood is of little value but the heartwood which is hard and blackish is used in cabinet making. This is a good quick growing shady tree for the roadside. The pods are flat and woody. Grown from seed. Distance apart 45 feet.

64. *Pyllanthus districhus.* E. Star gooseberry; Ver. harfar-auri.

A small tree with dark green pinsiate leaves and smooth grey bark. The leaflets are thin and pointed. The tiny reddish brown flowers are borne in slender clusters along the stems. The fruits which are often borne in dense masses are alike large round ribbed pale green buttons each having a hard stone in the centre. The fruits are acid and juicy and make a delicious preserve. The tree flowers in the beginning of the hot season and the fruit is ready in May-June. Sometimes fruits are borne at intervals throughout the year. Grown from seed or cuttings. Distance apart 25 feet.

This tree is more suitable for Parks and gardens than for the roadside.

65. *Phyllanthus Emblica.* Ver. amla, aonla.

A small deciduous tree with greenish small feathery leaves, many branches and smooth greenish grey bark. The small greenish yellow flowers are borne along the small branches. The round fruit is yellowish or brownish with a hard stone in the centre surrounded by fleshy acid astringent covering. The fruits are used for pickles and preserves and also eaten by children. The acid taste changes to a sweetish taste in the mouth. It is an important article in Indian medicine. The bark is used for tanning. The wood is hard and close grained and is used for agricultural impliment. Grown from seed. Distance apart 30 feet.

66. *Pitheco-lobium* Saman. E. Rain tree; H. Bilaiti siris.

A large practically evergreen quick growing tree with dark tree with dark green foliage, spreading branches and rough blackish bark. The powder-puff shaped pink flowers are borne at the end of the branches. The pods are about 8″ long containing several seeds embedded in a pulp that has a sweetish taste and is eaten by animals. The branches are rather brittle. The wood is white soft and not very useful. Grown from seed. Distance apart 60 feet.

67. *Polyalthia Longifolia.* H. Ashopalav, asok; G. Asupalo.

A handsome tall growing evergreen shady tree with dark long pointed green glossy leaves with wave margins and a straight trunk. The greenish flowers are borne in March-April

in loose bunches on the small branches and are usually hidden in July-August . They are eaten by various creatures especially by flying foxes. The leaves are used for preparing festoons for house decoration. This tree is confused with the real ashok which is saraea indica. The wood is white, fexible and even grained and used for various purposes. Grown from seed. Distance apart 35 feet.

68. *Poinciana regia syn. Delonix regia.* H. Gul mohur, E. gold-mohur.

A well known medium sized deciduous tree with feathery leaves and large crimson or scarlet or orange flowers. It remains leafless for many months but is gorgeous in April and May when the flowers and new leaves appear. The large long flat brown pods hang on the tree often till the flowers appear next year. It is quick growing and grows readily from seed. The wood is of little value. Distance apart 40 feet.

69. *Pongamia glabra.* E. Indian beech; H. Kiramal; G. Karanj; K. Hoghe.

A medium sized handsome hardy evergreen tree with bright green shining leaves and smooth greyish brown bark. The pretty lilac coloured flowers are borne in great profusion in clusters in May-June. The broad woody pods each contain a single seed and take nearly a year to ripen. The leaves are often attached by a fungus which causes brown spots. They are bitter and not eaten by animals. The seeds yield a medicinal oil. The wood is not very useful. This tree grows well on the seashore and near water but also grows in dry places. Grown from seed. Distance apart 35 to 40 feet.

70. *Pterocarpus indicus.* E. Padak; H. Vijyasar; G. Bio; K. Hanemer.

A handsome lofty evergreen tree with dark green shining leaves and olive grey bar. The small golden yellow sweet scented flowers are borne in the hot season in clusters at the ends of the branches. The pod is flat and round with a broad wing. The heartwood is dark brick-red and is used for building, cartwheels, furniture etc. Grown from seed. Distance apart 40 feet.

71. *Pterospermum acerifolium.* H. Kanak champa.

A handsome medium sized evergreen tree with large round leathery leaves which are dark green above and silvery grey

underneath. The twigs are covered with a rusty coloured down. The bark is fairly smooth and dark grey. The large white sweet scented flowers are borne singly from February to April. The fruit is a large woody capsule containing numerous brown winged seed. The branches are liable to die back. The wood is used for planks etc. The leaves cause a great deal of litter especially on February-March. Grown from seed. Distance apart 40 feet.

72. *Pterospermum suberifolium.* H. Muchkand.

A medium sized evergreen tree with oblong leaves set in one plane or opposite sides of the twigs. They are usually irregularly lobed, dark green above and silvery below. The fairly large white sweet scented flowers are borne singly in the axils of the leaves. The narrow pointed woody fruit is covered with white velvety down and contains a number of winged seeds. The wood is hard and tough and used for building, cart making etc. Grown from seed. Distance apart 25 to 35 feet.

73. *Randia dumetorum.* H. Main Phal; G. Mindal.

A small evergreen tree with stiff branches armed with spines and dark green leathery leaves. The white or greenish yellow fragrant flowers are borne singly on two or three together in the axils of the leaves. The fruit is an oval yellow berry. Grown from seed. Distance apart 25 feet.

74. *Saraca indica.* E. Asoka; H. Ashok; K. Ashoka.

A small spreading evergreen tree with dark green leaves and smooth brown bark. When the leaves are young they are reddish in colour and hang down limply in bunches. The bright red flowers are borne in clusters close to the branches. The flat leathery pods are covered with netlike markings. This tree is sacred to the Budhist as Gautama Budha was born beneath its shade. The wood is not valuable. Grown from seed. Distance apart 30 feet.

75. *Schizolobium excelsum.*

A tall handsome tree resembling gulmohr the leaflets being somewhat larger. It bears brilliant yellow flowers in open clusters at the ends of the branches in the hot weather. The pod is short and flat containing a single seed. It bursts when ripe. The trunk is tall and straight and the bark is greyish pink. The branches are rather brittle. Grown from seed. Distance apart 45 feet.

76. *Spathodia companulata.* E. Scarlet bell tree.

A fairly large evergreen tree with large pinnate leaves and grey bark. It bears large showy scarlet bell shaped flowers in bunches at the tips of the branches in January-February and also at intervals during the year. The fruit is long pointed woody and erect and ripens in June-July. This is a good shady tree for the roadside. Easily grown by cuttings. Distance apart 40-45 feet.

77. *Sterculia alata.*

A very tall deciduous tree with a straight trunk, smooth grey bark and broad heart shaped leaves. The small greenish flowers are borne in dense clusters among the branches. They have an unpleasant smell. The fruit is large almost spheical and woody containing a number of winged seed. The trunk of the tree is often strengthened by several narrow buttresses. Grown from seed. Distance apart 40 feet.

78. *Sterculia foctida.* E. Dung tree; H. Jangli badam.

A tall handsome deciduous tree with spreading branches and leaves crowded at the ends of the branches, The branches are whorled and the tree sometimes takes an umbrella shape. The leaflets are long and radiate from the ends of long leaf stalks. Inconspicuous dull purplish flowers are borne at the ends of the branches in February-March. They have a very offensive smell. The boat shaped pods are usually borne in hunches of tree to five each pod containing a few large black seeds. The wood is light and of little value. Grown from Distance apart 40 to 45 feet.

79. *Swietenia macrophylla.* E. large leaved mahogany.

A large evergreen tree with dark green leaves and rough brown bark. The inconspicuous white flowers are borne in loose clusters among the leaves. The fruit is a large woody oval capsule containing a number of brown winged seeds. The young trees bear larger leaves and may be mistaken for a different variety. The wood is of good quality and may be used for many purposes including furniture. Grown from seed. Distance apart 40 to 50 feet.

80. *Swietenia Mahogoni.* E. Spanish mahogany.

A large evergreen tree with small dark green shining pointed leaflets and rough brown bark. The tender leaves are a bright emerald green. Young plants have much larger leaves and

may be mistaken for S. macrophylla. The small greenish yellow flowers are borne in open clusters in the axils of the leaves. The fruit is a hard woody spherical capsule containing many brown winged seeds. The wood is very durable and is world famous and largely used for furniture shipbuilding etc. This is a good shady tree for the roadside. Grown from seed Distance apart 40 to 50 feet.

81. *Tamarindus indica.* E. Tamarind; H. Imli; M. Chinch; G. Amli; K. Hunise.

A large handsome spreading evergreen tree with small thick jade green leaflets and rough dark grey bark marked with cracks. The feathery leaves are bright emerald green when young and give the tree a distinctive appearance. It is one of the best known Indian trees and grows easily in any kind of soil. The pods are long curved and irregularly swollen. The acid pulp is a favourite ingredient in curries and chutneys and a large trade is carried on in it. The seeds are eaten in times of scarcity. The wood is hard and is used for wheels, mallets, planes etc. The tree has many medicinal uses. It is a long lived tree and good for the roadside. Easily grown from seed. Distance 50 feet

82. *Terminalia Arjuna.* E. White murdah; H. Kohas; M. Sadhha; K. Matri.

A fairly large deciduous tree with narrow blunt leathery leaves arranges opposite to each other. The small yellowish flowers are borne in open clusters at the ends of the branches and resemble mango blossoms from a distance. The fruits are woody pear shaped and have five narrow wings running from the tip to base. Each fruit contains a single seed. The bark is pinkish grey and used for tanning. The wood is hard and used for buildings, carts etc. The bark and the leaves are used in medicines. Flowers appear in April-May. Grown from seed. Distance apart 40 feet.

83. *Terminalia Belerica.* E. Belleric myra bolan; H. Beheda; M. Beheda; G. Beheda; K. Teri.

A large handsome deciduous tree with large pointed leathery leaves, brown bark and a tall straight trunk which is often buttressed. The small inconspicuous greenish yellow flowers have an offensive smell. The rather small oval or spherical velvety fruit contains one seed. They are eaten by cattle. The

kernals are eaten by men. The leaves can be used as fodder. The wood is not durable and is used for planking, packing cases etc. The fruit is one of the myrobolans of commerce and is used for dyeing and tanning. Grown from seed. Distance apart 45 to 55 feet.

84. *Terminalia catappa.* E. Indian almond; H. Badami; K. Velag.

A tall ornamental deciduous tree with large shining blunt leaves and branches spreading horizontally in whorls from a straight stem. The rough bark is greyish brown. The leaves are wide at the apex and taper towards the leaf stalk. They turn a bright crimson when ready to drop. The fruit is egg shaped but flattened and pointed. It contains a single nutlike seed embedded in a red fibrous pulp. The kernels are eaten. The bark and leaves yield a black dye. The wood is not very useful. Grown from seed. Distance apart 40 feet.

85. *Terminalia chebula.* E. Black myrobolan; H. Har; K. Anilekai;

A tall deciduous tree with fairly large pointed leaves and thick dark brown bark. The small yellowish white flowers are borne in narrow spikes mostly at the ends of the branches. They have an unpleasant smell. The small oval fruits each contain a single seed which is sometimes eaten. These fruits are the most important of the myrabolans and are used in tanning and dyeing as well as ink making. The tree had medicinal value. The wood is hard and used for furniture as well as carts, house building etc. Grown from seed. Distance apart 35 to 40 feet.

86. *Tectona grandis.* E. Teak; H. Sagun; K. Tejin.

A tall deciduous tree with large broad pointed opposite leaves, greyish brown bark and a straight trunk. The leaves are rough dark and green above and pale down below. The small whitish flowers are borne in very large open bunches at the ends of the branches. The small round fruit is soft and spongy containing a single seed. The flowers appear from June to August and the seeds ripen in December-January. The leaves turn very dingy before dropping. Grown from seed. Distance apart 30 feet.

87. *Tectona Hamiltoniana.*

A medium sized deciduous tree with fairly large oval pointed leaves which are rough above and downy below. The bark is brownish grey and peels off in thin flakes. The small blue flowers are borne in large open clusters at the ends of the branches in April-May making the tree quite attractive. The fruit is a small one seeded berry. The wood is light brown of good quantity but heavier and harder than teak. Grown from seed. Distance apart 35 feet.

88. *Thespasia populnea.* E. Tulip tree; H. Paras pipal; G. Paras piplo; K. Huvarsi.

A medium sized evergreen tree with dark green heart shaped pointed leaves and rough dark brown bark. The large funnel shaped flowers are yellow with crinkly petals and a dark red centre when they open but fade to a dull pink or purple when about to wither. The smooth oblong fruit about 1½″ diam. contains a number of silky seeds. The bark yields a strong useful fibre. The wood which is of a reddish colour is strong and durable and is used for gun stocks, carts etc. The tree has many medicinal uses. Easily grown from cuttings. Does well on the sea coast and in moist places. Distance apart 35 to 40 feet.

Lino—S 2862—5

APPENDIX A—(Chapter I—Paragraph 3)

Statement showing arboricultural receipts and expenditure during the financial year 195 —195

DIVISION—

SUB-DIVISION—

ROAD
CANAL

Receipts.	Rs	as.	p.	Expenditure.	Rs.	as.	ps.	Remarks.
Sale of trees cut down ...				Servants (Ma is, Bhistis, etc.) ...				
Sale of fallen trees ...				Cooly labour ...				
Sale of loppings ...				Cost and carriage of seed s and plants ...				
Income from grass ...				Construction of wells ...				
Other income from annual produce (fruits, lac, etc.).				Fencing ...				
Miscellaneous receipts (a) ...				Tools and plant ...				
				Miscellaneous (a) ...				

(a) Explain large miscellaneous receipts or expenditure in remarks column.

APPENDIX "C"—(Chapter II)

Annual Arboriculture Progress Report

.....DIVISION

Serial No.	Name of Canal.	Lengths in miles.	Total possible new plantation at beginning of year.	New plantation.		Percentage.		No. of 2nd, 3rd and 4th year trees maintained.	Proceeds of sales.	Total annual expenditure on arboriculture.	Average expenditure per tree.	Remarks by Executive Engineer.	Remarks by Superintending Engineer.
				As per programme.	Actually executed.	Excess.	Deficit.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14

N.B.—This Statement C will be prepared in the Executive Engineer's office and submitted in duplicate, with the general report, to the Superintending Engineer, during the first week of January. They should be returned by him to the District Office before the end of that month.

Note.—The number of trees planted to replace casualties is not included in the figures in Columns 4, 5 and 6.

Dated 195 .

Executive Engineer,

Division.

APPENDIX D—(Chapter II—Paragraph 14)

Arboriculture Progress Report for the Quinquennium to

_____ DIVISION

Name of the Road—Canal

Length of the Road—Canal Miles

Expenditure during quinquennium 19 19 19 19 19 Total

Mile No.	Furlong No.	Maximum number of trees that can be accommodated.	Number of trees at the beginning of the quinquennium.			Number of trees planted during the quinquennium.	Number of casualties.		Number of trees at the end of quinquennium.				Remarks and reasons as regards casualties etc.
			Tress established.	Trees requiring maintenance.	Total.		Amongst these in column 4.	Amongst those in column 5.	Trees established.		Trees requiring maintenance.	Total.	
									Out of those in column 4.	Out of those in column 5.			
1	2	3	4	5	6	7	8		10	11	12	13	14

Executive Engineer.

Division.

APPENDIX "E"

Simple Insecticides.

1. *Kerosene emulsion.*—Mix two chataks of hard soap (or soft soap) in half a gallon (2½ seers) of boiling water. Stir till the soap is well dissolved. Then add at once one gallon of kerosene oil. Churn the mixture vigorously till it becomes creamy. *This forms a stock solution.* For use, add eight parts of water to one part of this stock solution.

2. *Copper sulphate solution.*—Take two *chataks* of copper sulphate (tuntia), which may be purchased in any bazaar. Dissolve in half a gallon (2½ seers) of boiling water. Add two gallons of cold water for use.

3. *Tobacco water.*—Boil four *chataks* of dried tobacco leaves in half a gallon of water for about half an hour. Dissolve in this one *chatak* of hard soap. Add three gallons of cold water for use.

Conditions on which trees were planted

1. Only trees of a kind or kinds approved by the Executive Engineer of the Division / President of the District Local Board and specified in the permission shall be planted.

2. The planting shall not be done by seed or by seddlings of less than two years' growth.

3. The trees shall be planted in regular lines and at such distance from each other and from the middle of the roadway as the Executive Engineer of the Division / President of the District Local Board may prescribe.

4. The planter shall provide for the irrigation and protection of the trees until they grow sufficiently large to need no more attention.

5. On planting a tree the planter shall give intimation to the Mamlatdar concerned specifying the kind of tree planted and its position.

6. When the trees planted under the above conditions have grown sufficiently to be no longer in need of irrigation or protection, the planter shall be entitled to obtain from the Executive Engineer of the Division / President of the District Local Board a sanad declaring his ownership of the trees.

APPENDIX F—(Chapter XIII—Paragraph 3.)

Register of trees planted

Taluka

Name and class of road

Name of planter with parentage caste and residence.	Year of planting.	Kind of tree.	Number of trees.	Position of trees.				Date of entry in register.	Remarks.
				Mile and furlong.	Side of road.	Village.	Survey number of plot.		
1	2	3	4	5	6	7	8	9	10

APPENDIX G—[Chapter XIII, Paragraph 1(4)]

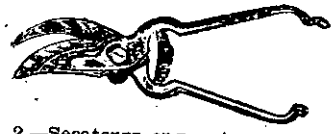
Form of sanad of ownership of trees planted by private persons on Government roads in district.

Serial No.	Name of planter, father's name, caste and residence.	Name and class of road on which trees have been planted.	Taluka and village where the road is situate.	Survey No. of plot or nearest plot.	Number of mile and furlong.	Kind of trees planted.	Number of trees planted.	Condition on which the sanad is granted.
								The trees planted are the property of the planter and his successors, but he will not have power to lop or fell without the permission of the Executive Engineer of the Division / President of the District Local Board and he will have no claim to the land on which trees stand. He will, however, be entitled to take the fruit and all dry or fallen wood as well as all lopping made in ordinary course of arboricultural operations. The conditions on which trees were planted are noted on the next page.

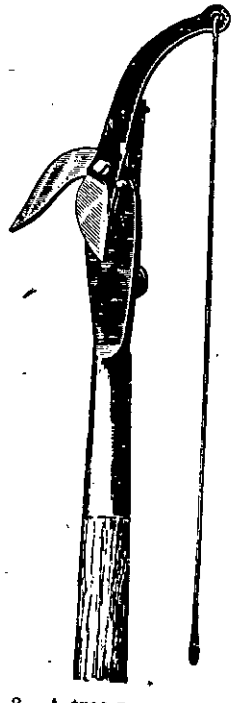
Dated 19

Executive Engineer.
President, District Local Board.

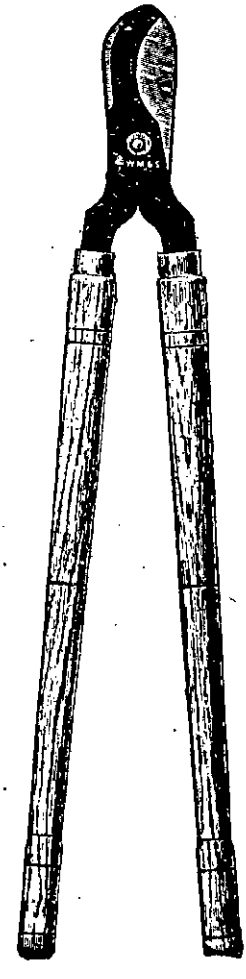
1.—A soil "Aerator."



2.—Secateurs, or pruning shears.

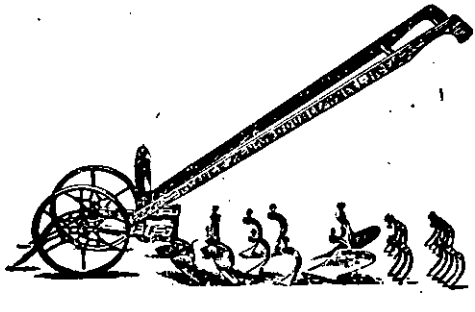


3.—A tree-pruner.



4.—A branch-pruner.

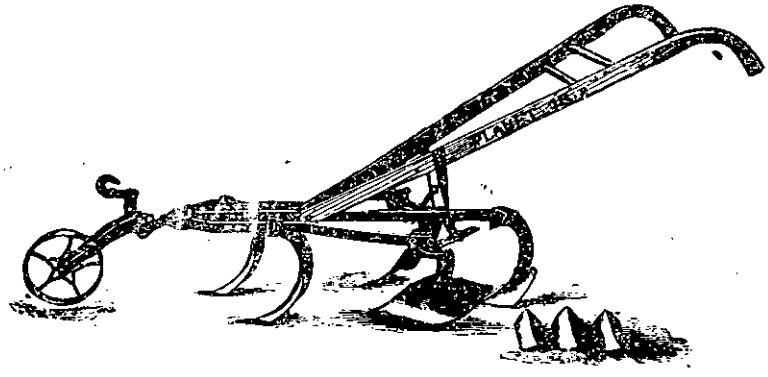
5.—Plucking or pruning hook.



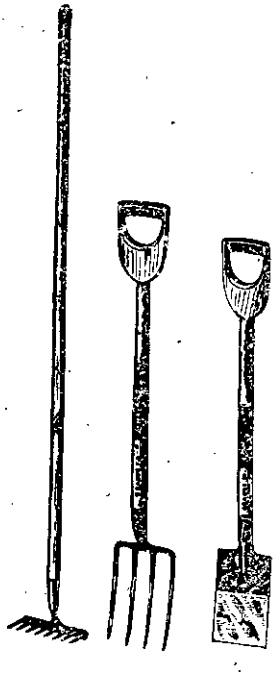
6.—Double wheel hoe.

Arboricultural Tools.

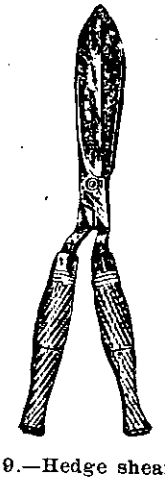
G.P.Z.P. POONA.1950



7.—Cultivator.



8.—A useful trio.

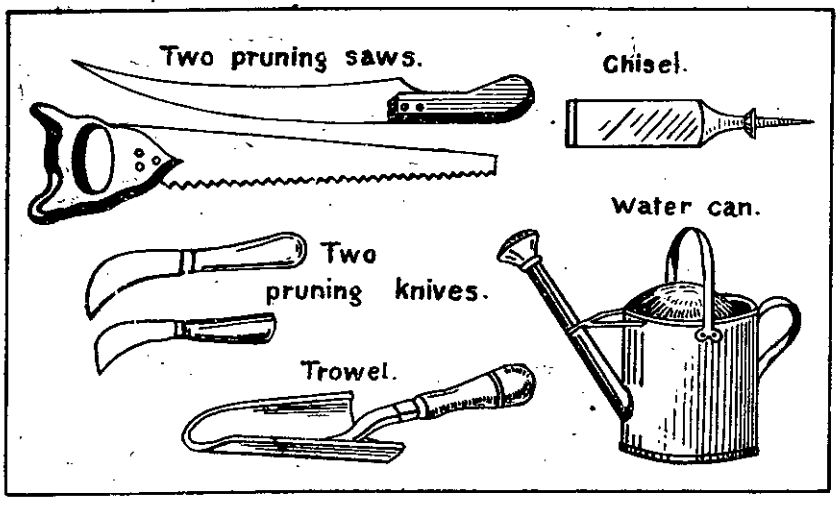


9.—Hedge shears.

Arboricultural Tools.

G.PZ.P. POONA. 1950

PLATE I. (Completed)
Chapter IV



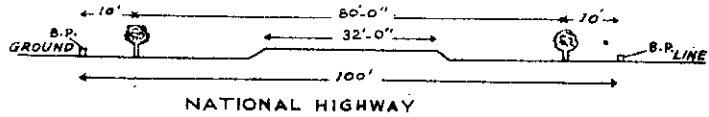
Arboricultural Tools.

G.PZ.P. POONA. 1950

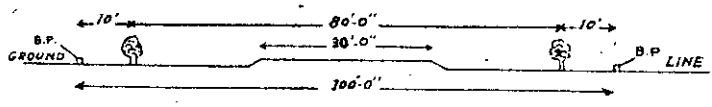
PLATE II

AVENUE DISTANCES

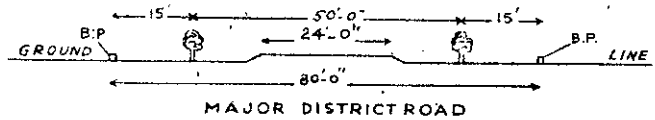
ALONG ROADS
(CHAPTER VII-PARA 4)



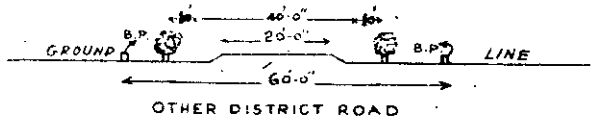
NATIONAL HIGHWAY



PROVINCIAL HIGH WAY



MAJOR DISTRICT ROAD



OTHER DISTRICT ROAD

VILLAGE ROAD

DRAWN: SMS
TRACED - C.PHANSE

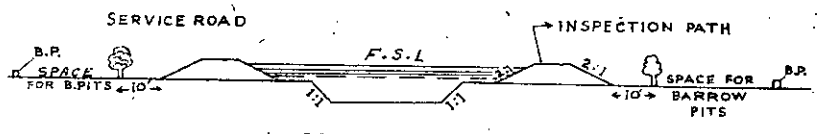
S.P.L.P. POONA. 1931

PLATE II (CONTD.)

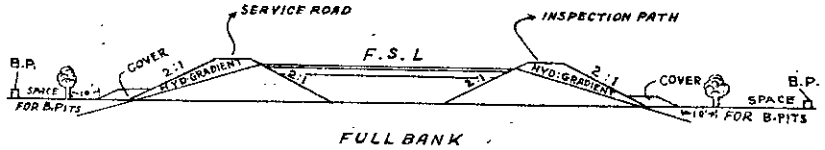
AVENUE DISTANCES ALONG CANALS

(CHAPTER VII - PARA 4)

FULL CUTTING



PARTIAL CUTTING



FULL BANK

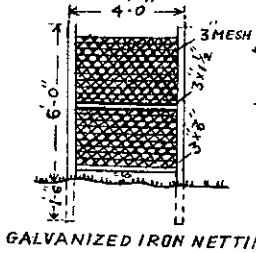
DRAWN:- SKB

TRACED:- C.PHANSE

G.P.E.P. POONA. 1951

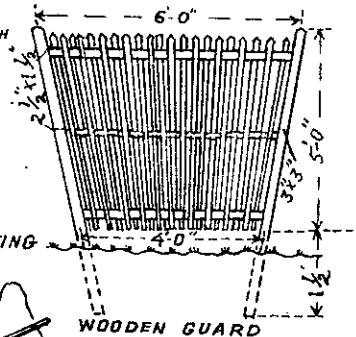
DETAILS OF ARBORICULTURE

(CHAPTER VII - PARA 11 & CHAPTER VIII - PARA 2)



GALVANIZED IRON NETTING

1



WOODEN GUARD

2

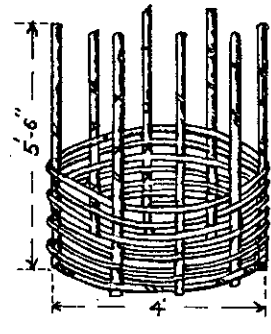
LIGHT LADDER

3

4

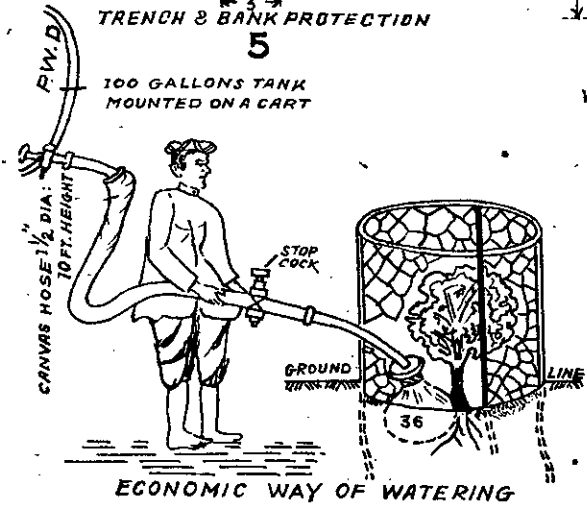
TRENCH & BANK PROTECTION

5



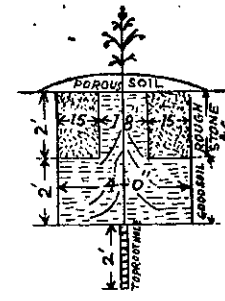
WATTLE FENCING

6



ECONOMIC WAY OF WATERING

7



TREE HOLE WITH DRY STONE FILLING

8

TRATED.
C-PHANSE

CHECKED BY SLG

G.PZ.P. POONA, 1950.

TYPICAL INJURIES TO TREES & METHODS FOR THEIR CURE

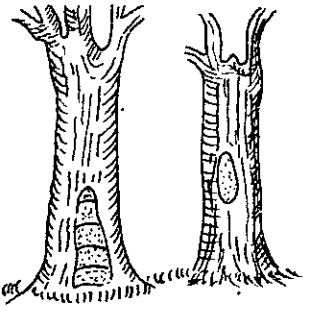
PLATE IV

(CHAPTER XI - PARA 16).

I

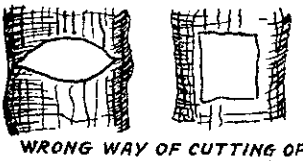
THESE TREE TRUNKS WITH HOLLOWS CAN BE FILLED WITH ASPHALT.

II



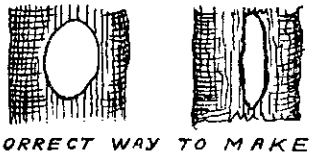
THE HOLLOWS IN THESE HAVE BEEN FILLED WITH CEMENT MORTAR.

III



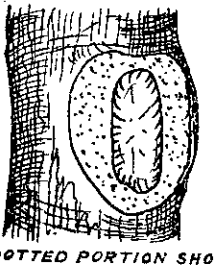
WRONG WAY OF CUTTING OPEN OLD INJURY FOR TREATMENT DELAYED HEALING.

IV



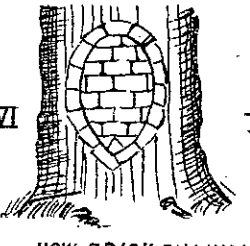
CORRECT WAY TO MAKE INCISIONS WOUNDS HEAL QUICKLY.

V



DOTTED PORTION SHOWS HOW CAMBIUM HAS BEEN SCRAPED TO PROMOTE QUICK GROWTH.

VI

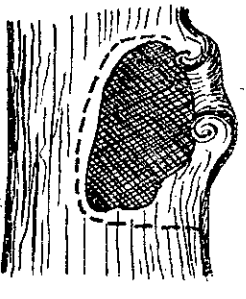


HOW BRICK FILLING WITH MORTAR COULD BE ARRANGED IN A CAVITY

VII

SLITTING BRANCHES OF A TREE NEAR THE FORK CAN BE SAVED BY INSERTING THE BOLTS AND WIRE AS ILLUSTRATED

VIII



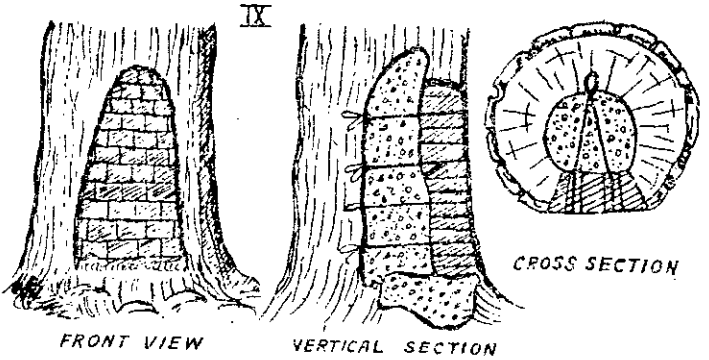
THE DOTTED LINE ON THIS ROTTING WOUND ON A STUB OF THE TREE SHOWS THE CORRECT POSITION TO CUT THE BARK AROUND A WOUND FOR TREATMENT

CHECKED BY

TRACED C.PHANSE

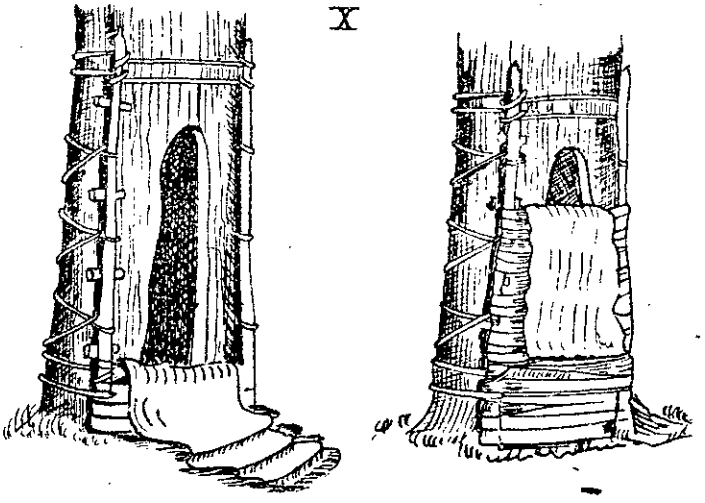
G.P.Z.P. POONA. 1951

IX



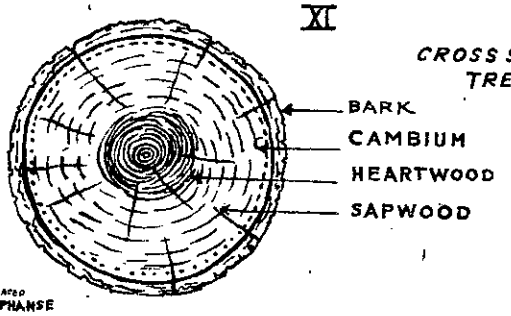
VIEW AND SECTIONS SHOWING HOW ASPHALT AND BRICKS OR DRESSED STONES ARE USED FOR FILLING A BASAL CAVITY

X



PROCESS SHOWING HOW LARGE CAVATIES AT THE BASE OF THE TREE COULD BE FILLED UP WITH CEMENT

XI



CROSS SECTION OF A TREE TRUNK

TRACED C-PHANSE
CHECKED BY: SLPM

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